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EARNINGS ANNOUNCEMENT EFFECTS TO THE ORDER BOOK:

Evidence from OMX Nordic Exchange Helsinki

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ABSTRACT

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PURPOSE OF THE STUDY

The objective of this study is to investigate earnings announcement effects to order book composition. The primary aim of this study is to study whether information asymmetry increases before the anticipated disclosure of earnings report. The secondary aim is to investigate how the companies' decision to disclose earnings announcement during or outside continuous trading affects information asymmetry. In addition, this research investigates differences between annual and quarterly earnings announcements.

DATA

The data, 338 annual and quarterly earnings announcements and trading data from OMX Nordic Exchange Helsinki enables this study to form a comprehensive picture of the market wide reaction to earnings announcements. The data covers full order book information for the companies, which have belonged to OMXH25-index between December 1st 2004, and August 31st 2007.

RESULTS

In contradiction to previous findings, I document that the liquidity provided is unaffected during the pre-announcement period and significantly improved after the release of the disclosure. Furthermore, this study provides evidence that if companies choose to disclose their earnings outside trading hours their shares are likely experience improved liquidity, increase in trading volumes and decrease in intraday volatility.

KEYWORDS

Bid-ask spread, Depth, Earnings Announcements, Information Asymmetry

TULOSJULKISTUSTEN VAIKUTUS TARJOUSKIRJAAN:

TUTKIMUSTULOKSIA OMX POHJOISMAINEN PÖRSSI HELSINGISTÄ

TUTKIMUKSEN TAVOITTEET

Tutkimuksen tavoitteena on tutkia tilinpäätösten vaikutusta tarjouskirjan koostumukseen. Tutkimuksen ensisijaisena tavoitteena on selvittää lisääntykö informaation epäsymmetrisyys ennen odotettavissa olevaa tulosjulkistusta. Toissijaisena tavoitteena on tutkia miten yritysten päätös julkaista tilinpäätöstiedote jatkuvan kaupankäynnin aikana tai sen ulkopuolella vaikuttaa informaation epäsymmetrisyyteen.

DATA

Tutkimukseen käytetyt 338 tilinpäätöstä ja osavuosikatsausta, sekä kaupankäynti tiedot OMX Pohjoismainen Pörssi Helsingistä mahdollistavat muodostamaan kattavan käsityksen markkinoiden reagoinnista tulosjulkistuksiin. Kaupankäynti tiedot pitävät sisällään kaikki tarjouskirjan tapahtumat ajanjaksolta 1. joulukuuta 2004 – 31. elokuuta 2007.

TUTKIMUSTULOKSET

Aiempien tulosten vastaisesti tulokseni osoittavat, että tarjottu likviditeetti säilyy muuttumattomana ennen tulosjulkistusta ja kasvaa huomattavasti heti tulosjulkistuksen jälkeen. Lisäksi tulokseni osoittavat että jos yritys päättää julkistaa tuloksensa jatkuvan kaupankäynnin ulkopuolella sen likviditeetti parantuu, kaupankäynti volyyymi kasvaa ja päivänsisäinen volatilititeetti pienenee.

AVAINSANAT

Osto- ja myyntihinnan välinen ero, tarjouskirjan syvyys, tilinpäätökset, informaation epäsymmetrisyys

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Definitions

Some of the terms and jargon used in this paper may not have self-explanatory meaning. In order to facilitate the reading, following terms have been collected and explained in this table. Further support is provided upon the occurrence.

After Market Trading	Trading phase where only manual trades can be concluded when criteria of the trade type are met. After market trading I is arranged during the post-trading session (18:31 – 19:00) and after market trading II in the pre-trading session (8:30 – 9:45).
Announcement time	The time at when the (earnings) announcement is disclosed in the trading system.
Bid-Ask Spread	The difference between best bid and ask price, can be intrepid in monetary or relative form.
Call, Auction	Trading phase, during which orders are not matched automatically, but as a batching at the end of the trading phase.
Continuous trading	Trading phase, during which trading is conducted via order book and orders matched automatically. Reporting of contract trades is also possible.
Depth	See quoted depth.
Liquidity	The speed at which shares can be bought or sold. In this paper liquidity is seen to consist of bid-ask spread and depth.
Market model, Market microstructure	A set of rules and technical limitations that govern the trading.
Midpoint price	The price which is in between of the best bid and ask price.
Non-Announcement Period	In this study non announcement period is defined as days -32 to -3 prior the earnings announcements. Generally refers to period outside event window.
Odd-Lot Trading	Trading in smaller quantities than it is allowed. Odd-lot trading is usually organized in special, usually very illiquid, order book.

Order book	Technical storage at which buy and sell orders are collected and where the trading is executed.
Order Management	Order management includes order entry, order modification and cancellation actions for order.
Post-Announcement Period	Trading period after the disclosure of the earnings announcement. In this paper periods [-34 to -1].
Pre-Announcement Period	Trading period before the disclosure of the earnings announcement. In this paper periods [1 to 34].
Pre-Call	Order book state in calls when order management is allowed. Period with no transparency, where the trading members can only see their own orders.
Price-internal-time priority	A rule at which orders are matched in the order book. According to the rule an order at best price is always matched first. If there are two or more orders at same price level, brokers own orders are preferred instead of time.
Quoted depth	Number of shares offered at best bid and ask prices.
Specialist	A person, who is responsible for maintaining the market for any particular share.
Trading Session	The period during trading hours in which automatic order matching including opening, closing and intraday calls takes place and manual trades may be reported.
Tick size	The minimum price variations allowed
Uncross	Order book state in call when final price determination and share allocation together with order and trade information dissemination takes place.

1. Introduction

1.1. *Background and Motivation*

Quarterly and annual earnings announcements are a regular source of information for investors and other stakeholders and have thus always raised special enthusiasm among market participants. As the range of market participants and the tools used to process new information have grown tremendously during the last few decades, companies can still be split fairly equally into companies who disclose their earnings outside trading hours and those who disclose their earnings during the continuous trading. These observed mixed practices, suggest that information should be processed equally effectively regardless of the timing of the earnings announcement. However, academic literature suggests that information asymmetry is resolved in differing degrees depending on whether earnings announcements are of quarterly or annual types (Salamon and Stober 1994) and whether the announcements are made during or outside of trading hours (Genotte and Trueman 1996; Francis, Pagach, and Stephan 1992; Pronk 2006).

If indeed it is the case that earnings announcements are resolved differently depending on whether the announcement is disclosed during or outside trading hours, one would expect the companies and investors to prefer either one. The regulators, however, also seem to have mixed preferences over the timing of the announcements. While in Sweden, OMX Nordic Exchange Stockholm has forbidden companies to disclose any price sensitive information during the opening and closing auctions, in Finland, the Securities Market Act¹ requires companies to disclose all price sensitive information without undue delay allowing some levy for companies to choose the timing of their disclosure.

This study aims to shed light on the differences in information processing, caused by different earnings announcement schedules. The high quality data from OMX Nordic Exchange Helsinki enables this research to dig in deeper to the components of the order

¹ According to the Finnish legislation the interim report shall be published without undue delay, however, not later than within two months from the end of the report period. The publication date shall be published immediately after a decision thereon (Securities Market Act, Chapter 2, Section 5c).

book, by analyzing not just the bid-ask spread, the difference between best bid and ask price, and quoted depth, number of shares offered on best bid and ask price, but also to look at the variables such as volume weighted spread and weighted liquidity 5 percentage points around the midpoint price¹. Moreover, instead of merely focusing on specialist or market makers actions, the comprehensive data used allows this study to form an objective view on the market wide reaction to earnings announcements.

1.2. Research Problem

In efficient markets all new information should be quickly incorporated into prices, so that the price also becomes part of the new information. In financial markets, this information can be observed from the bid and ask prices, which present the market value at which investors can buy or sell their securities. In addition to bid-ask spread, equally important, but less investigated, is the quantity aspect of the pricing. Lee, Mucklow and Ready (1993) point out that, if market participants believe that the probability that some traders possess superior information has increased, they may respond by increasing the bid-ask spread. Alternatively, they could protect themselves by quoting less depth (offering to trade less at each quoted price). Lee, Mucklow and Ready (1993) show that in theory the combination of wider (narrower) spreads and lower (higher) depths is sufficient to infer a decrease (increase) in quoted liquidity.

Kim and Verrecchia (1994) suggested that information asymmetry may be larger at the time of an announcement than in non-announcement periods. They hypothesized that some market participants are able to process earnings announcements into private, and possibly diverse, information about a firm's performance at some cost. As earnings announcements stimulate informed judgments, the likelihood of informed traders increases. This decreases the willingness of non-informed investors to provide liquidity and thus the market as a whole may become less liquid as a direct consequence of more disclosure.

¹ Please refer to Chapter 5 for more details

Academic research on earnings announcements has focused on specialist markets and market specialists' management of order book spread and depth. Research literature has demonstrated that specialists manage both order book spread and depth to cover transaction costs and to protect themselves from information risk, or the risk of dealing with informed traders (Kavajecz 1998; Easley and O'Hara 1992; Glosten and Milgrom 1985). However, surprisingly little effort has been given to how market as a whole reacts to the earnings announcements. While specialists may be able to protect themselves against informed traders, the overall market reaction to earnings announcements may differ significantly from specialists' reaction.

Recently, the academic focus has shifted to the timing of the earnings announcements. Libby, Mathieu and Robb (2002) used intraday data of specialist quoted bid-ask spread, quoted depth and trading volume to study whether the specialist reactions to overnight and day time earnings announcements differ in Toronto Stock Exchange (TSE). They found that companies experience a wider spread and lower depth after announcements disclosed during non-trading hours than announcements disclosed during trading hours. On the other hand, conflicting evidence is provided by Pronk (2006), who studied specialist actions in NYSE and American Stock and options Exchange (AMEX). He documented that companies, which disclose their earnings overnight, exhibit a smaller spread and higher depth than after daytime announcements. Pronk (2006) suggest the difference between his results and Libby, Mathieu and Robb (2002) results could at least partly be related to the differences in market microstructure.

The purpose of this study is to provide evidence whether the expected increase in information asymmetry decreases the liquidity before the disclosure of the earnings announcements. By extending the research into limit order book market this study aims to provide further evidence on differences in investors behavior around annual and quarterly announcements and on the other hand around earnings announcements disclosed during and outside trading hours.

The research questions this study aims to answer are:

- Does the information asymmetry increase prior to the earnings announcements?
- Is there a difference in the information content of annual and quarterly earnings announcements and in market reaction to them?
- Are there differences in the price determination and information processing between the earnings announcements disclosed outside and during trading hours?

The data, 338 annual and quarterly earnings announcements of 32 companies, used in this study has been acquired from the OMX Nordic Exchange Helsinki databases consisting of both the disclosure times of earnings announcements and trading data. In order to ensure the quality of the analyzed information this study is limited on the companies, which have belonged to OMXH25-index¹ between December 1st 2004, and August 31st 2007. The trading data used in this study is retrieved from Computershare's Securities Markets Automated Research Trading and Surveillance (SMARTS) system.

1.3. Key Results and Contribution

This study extends the earnings announcement research by (1) providing further evidence about trading hours vs. overnight announcements after the recent mixed academic results (2) extending the study to limit order book market (instead of specialist market) and to a new geographical area (OMX Nordic Exchange Helsinki) and (3) analyzing new variables to measure the order book quality.

The main result of my study, if companies choose to disclose their earnings outside trading hours, their shares are likely experience smaller spread and higher depth, than if they would have made the disclosure during the continuous trading, provides further support to Pronk (2006) findings. The in-depth analysis reveals that changes in the order book depth are not limited to the quoted depth, but both the total order book depth and

¹ OMXH25 index consists of the 25 most actively traded stocks on the OMX Nordic Exchange Helsinki. The index is a capitalization weighted stock price index, on which the maximum weight of one company is limited to 10 percent. The composition of the OMXH25 index is revised twice a year.

liquidity 5 percentages around the midpoint price are also positively affected by the choice to disclose earnings announcement outside trading hours. Furthermore, the decision to disclose earnings announcement outside trading hours also seems to increase trading volumes, suggesting that market as whole is likely to benefit from increased time to analyze the disclosure.

In line with Libby, Mathieu and Robb (2002) I find no conclusive evidence that the bid-ask spread would differ between annual and quarterly announcements. However, evidence is provided that investors increase trading activity around annual earnings announcements, which is observed through improved order book depth, increase in trading volumes, increase in typical trade size and also increase in volatility.

This study fails to provide evidence of decreased liquidity, a supposed effect of increased information asymmetry, during the pre-announcement period. The evidence provided in this study suggests that during the pre-announcement period liquidity differs only slightly from its non-announcement period median values, while right after the disclosure of earnings news the liquidity offered is significantly improved. Evidence provided supports the view that the probable increase in search of private information before the disclosure of earnings announcement does not materialize into insider information.

1.4. Structure of the Study

The remaining part of this paper is divided up into seven chapters. Chapter 2, briefly discusses about the market microstructure issues and how they are likely to affect the results. Chapter 3 summarizes recent academic research on earnings announcement literature and presents the Hypothesis. In the Chapter 4, the sample data is presented. Chapter 5 presents the methodology used in this study and Chapter 6 present the univariate results. Chapter 7 discusses the correlation between the selected variables, while Chapter 8 presents the regression results. Concluding remarks are presented in Chapter 9.

2. Market Microstructure

As trading in TSE, NYSE and AMEX have concentrated around specialists and their actions, both Libby, Mathieu and Robb (2002) and Pronk (2006) have used specialists' reaction to earnings announcement as a proxy of overall market reaction. However, the fact that this paper aims to investigate the overall market reaction to earnings announcements might impede direct comparison to previous research for two reasons. Firstly, specialist reaction to earnings announcement may not be an accurate proxy for the overall market reaction as a specialist may implement his own view after the earnings announcement. If the specialist is uncertain of the earnings announcement effects to the share price, he may offer wider bid-ask spread and smaller depth. On the other hand, if he believes that the effect is positive (negative) he has incentive to buy (sell) the share. When investigating overall market reaction, it is more likely that several market participants have opposite views on the earnings announcement effects to a share price. A researcher is likely to observe this as narrower spreads and larger depths than if he would just investigate specialist reaction to the same earnings announcement.

Secondly, trading in OMX Nordic Exchange Helsinki resembles more that on the NASDAQ¹ and may thus be another source of deviation in results. Several researchers have documented significant differences in information processing between NASDAQ and NYSE. Huang and Stoll (1996) provide evidence that NASDAQ execution cost is twice the NYSE cost measured by; quoted spread, effective spread, realized spread, implied spread and post-trade variability. This evidence indicates that market structure itself may be a source of wider spreads and thus larger trading costs. In a more recent research, conducted after the SEC-mandated order-handling rules², Bessembinder (1999) documented that the trade execution costs remain larger on NASDAQ as compared to the NYSE in tick sizes, but the differential across markets is smaller than in

¹ While the market model of OMX Nordic Exchange Helsinki has more similarities with NASDAQ than NYSE market model, several differences nevertheless exist. One of them is that OMX Nordic Exchange Helsinki uses open opening call, through which the first trade during the continuous trading represents a batching of several orders in the order book.

² SEC-mandated order-handling rules (1997) required limit orders that were better than the market makers quote to be displayed.

earlier years. In addition, Van Ness, Van Ness and Warr (2001) provided evidence that the adverse selection is less for NASDAQ stocks than for NYSE stocks and that many of the factors they hypothesized to be correlated with adverse selection are significant determinants for only NYSE stocks.

In order to improve comparability to previous research, this chapter first discusses trading in specialist markets, secondly about the academic research related to U.S. stock market microstructure and finally about the trading in OMX Nordic Exchange Helsinki and its key differences compared to NYSE and NASDAQ.

2.1. Specialists and Limit Order Book Markets

In their competition for liquidity and listed companies, exchanges have developed different market models to facilitate trading. One of the most notable differences among exchanges is the division into a specialist driven auction market and a quote driven dealer market mechanism, of which the two of the most famous examples are NYSE and NASDAQ, respectively. The mere existence of these different ways to organize the trading reveals that none of the market models is likely to have superior, all around, capabilities to process information. As the price formation process between the exchanges differs at least to some extent, it is possible that the offered spreads and depths may also differ depending on which stock exchange the company's share is listed in.

Trading in equity securities on NYSE and AMEX generally involves a continuous two-sided auction. The trading process for each security is carried out at a specified location on the exchange floor and presided over by a specialist (Lee 1992). Specialists are charged with maintaining fair and orderly markets (e.g., maintaining a smooth sequence of prices and avoiding large price changes between successive trades) (Greene and Watts 1996). While competing with floor traders and limit orders, the specialist is required to better any limit order price before he can take the trade himself (see ¶2092 of the NYSE Rules).

Lee (1992) describes the trading in NYSE as follows: "When an order is placed with a broker, the instigator of the order specifies not only the number of shares to be bought or sold, but also the mode of execution. A market order is to be executed immediately at the best available price. A limit order is an order to buy or sell when a specified price is attained. The specialist maintains a list of limit orders at various prices on each side of the current quote. These orders are executed as prices move to the level specified in the order. When an order is large, it is sometimes more advantageous for a trader to issue a 'standing' order. A standing order is an order to buy or sell certain number of shares at the best available price over a certain time period. The order is given to a floor broker who is able to exercise discretion over the exact timing of the trades needed to fill the order by waiting in the 'crowd' at the specialist's post and responding to incoming orders by bettering the current quote. In terms of immediacy of execution, the market order is executed immediately, the standing order is like a limit order with priority execution and the limit order is only exercised when price conditions dictate."

The NASDAQ on the other hand is not physical entity. Trading in NASDAQ is organized electronically and it relies on market makers rather than specialists to facilitate trading and liquidity in stocks. For each stock, there is at least one market maker, who is required to give two-sided quote. The market makers are openly competitive amongst themselves and facilitate competitive prices. As this competition is evident in the limited spreads between posted bids and asks, the market makers on the NASDAQ will in some instances act very much like the specialists on the NYSE.

Greene and Watts (1996) investigated quarterly earnings announcements made by 100 NYSE listed and 100 NASDAQ listed companies disclosed during trading hours and suggested that different market structures (specialist versus dealer market, call auction versus continuous trading, etc.) may differ in their ability to impound information. Authors found that for non-trading hours announcements, the opening trade on the NYSE impounds most of the price response, whereas for trading-hours announcements, the response is spread evenly over the first several post-announcements trades. In contrast, the first post-announcement trade on the NASDAQ impounds most of the price response

regardless of announcement time. Nevertheless, Greene and Watts (1996) conclude that although their transaction time analysis indicates some differences in price discovery price adjust rapidly on earnings announcements in both exchanges.

The findings of Green and Watts (1996) are in contradiction to Francis, Pagach and Stephan (1992) who find no evidence that investors' opening trades reflect overnight announcement in formation in the NYSE. They argue that the absence of opening reaction seems to be due to traders submitting only partial orders at the open. They analyze this behavior to be attributed either to investors reluctance to submit full orders because of their effect on opening prices or to investors' postponing trades until they have observed the opening prices.

2.2. *Tick Sizes and the Optimal Share Price*

Among the issues affecting bid ask spread, trading volumes and liquidity, are exchange imposed limits and psychological aspects. Some of the most notable exchange imposed limits are tick size tables, the minimum price variations allowed, and round lots, the normal unit of trading for a security, while the most important psychological aspect relates to "optimal" share price. Angel (1997) documents, that from 1943 to 1994, the S&P Composite Index increased over 1,500 percent while the average New York Stock Exchange (NYSE) share price was almost unchanged, from \$32 to \$31. During the same period consumer price index over 500 percent, indicating that the real average share price dropped to a small fraction of its previous level. He argues that this phenomenon is at least partly related to the tick sizes.

The academic research of stock splits has focused primary on two explanations; signaling and liquidity. According to the signaling explanation firms may split their share in order to signal the market that the recent increase in share price is permanent, while according to the liquidity explanation, reduction in the share price makes it easier for small investors to afford a round lot of the stock and thus this increased liquidity should make

the company more valuable. Angel (1997) argues that companies tend to split their stock so that the institutionally mandated minimum tick size is optimal relative to the stock price. A large relative tick size provides an incentive for dealers to make markets and for investors to provide liquidity by placing limit orders, despite that it increases the quoted bid-ask spread.

The tick sizes have long been a subject of argument among market participants. Some, such as O'Connell (1997) and Ricker (1998), argue that smaller tick sizes benefit liquidity demanders as competition between liquidity providers is likely to force a reduction in the bid-ask spread. Others, such as Grossman and Miller (1988) and Harris (1997), argue that while such a change may benefit some liquidity demanders, it may damage liquidity providers, as it could increase their costs and thus decrease their willingness to provide liquidity.

Angel (1997) notes, that the optimal tick represents a trade-off between the benefits of a nonzero tick and the costs that a tick imposes. The tick sizes present unnecessary increase in the minimum bid-ask spread and thus increases transaction costs for investors. However, Angel (1997) presents several arguments why the optimal tick size is not zero. Firstly, as Harris (1991) noted, the nonzero tick simplifies information by reducing time spent bargaining. Secondly, a nontrivial tick enforces time and price priority in a limit order book, providing incentives for investors to provide liquidity with limit orders. Thirdly, a nonzero tick puts a floor on the quoted bid-ask spread, which provides incentives for dealers to make markets and thus increase liquidity.

Harris (1991) and Huang and Stoll (2001) point out that the tick rule is essential if time priority is to have meaning. Time priority has little meaning if the person who is first to quote the best bid can lose that position to someone who quotes only a penny more. Conversely, if there is not time priority, a tick rule is not necessary, because without a tick rule, customers could easily step ahead of dealers or conversely dealers and floor brokers could easily step ahead of customers. Huang and Stoll (2001) examine the source and the impact of a minimum tick rule by considering stocks traded in different market

structures analyzing stocks traded in London Stock Exchange (LSE) and NYSE. They conclude that the market structure is the exogenous factor responsible for the presence of tick size rules and other market microstructure attributes.

Goldstein and Kavajecz (2000) investigated the impact of reducing the minimum tick size on the liquidity of the market, after the NYSE reduced the minimum price variation for quoting and trading stocks from an eighth to a sixteenth in June 1997. They documented that while both spreads and depths (quoted and on the limit order book) declined after the NYSE's change, depth declined throughout the entire limit order book as well. Authors conclude that the combined effect of smaller spreads and reduced cumulative limit order book depth made liquidity demanders trading small orders better off; however, traders who submitted larger orders in lower volume stocks did not benefit, especially if those stocks were low priced.

Niemeyer and Sandas (1994) examine the Swedish market, which has different tick sizes based on share price, and find that the tick size has a significant influence on the bid-ask spread. Thus, a larger tick provides a higher minimum round-trip profit to a dealer who can buy at the bid and sell at the offer. Niemeyer and Sandas (1994) argue that if the relative tick size is too big, the profits from a wider tick size may be dissipated through vigorous competition for order flow and payment for order flow.

2.3. *OMX Nordic Exchange Helsinki*

OMX Nordic Exchange Helsinki, hereafter the Helsinki Stock Exchange (HSE), is part of the OMX Group AB¹, which operates stock exchanges in Nordic and Baltic regions. At the end of the September 2007 there were 160 shares or share series listed in the Helsinki Stock Exchange, with a total equity market turnover in 2006 of 288 billion euros. The trading in Helsinki Stock Exchange is completely automated, with trading conducted via direct connections between the member computer terminals and the exchange's central

¹ As of 27th of February 2008, OMX Group AB became part of NASDAQ Inc.

electronic trading system SAXESS. Listed companies are not required to provide market making for their shares, although some of them have done so, in order to improve the liquidity in their shares¹.

The tick size used for all the instruments listed in Helsinki Stock Exchange is 0.01 euros. Pronk (2006) conducted his study in NYSE and AMEX between July 1 1993 and June 30 1994, and Libby, Mathieu and Robb (2002) in TSE from January 1998 to December 1998. During this period tick sizes in NYSE were one eighth of a dollar, i.e. 0.125 dollar, while TSE used different tick sizes based on the absolute value of the share. As previously pointed out, Goldstein and Kavajecz (2000) found that the reduction in tick sizes in NYSE reduced both spreads and depths and made liquidity demanders trading small orders better off. While Niemeyer and Sandas (1994) found evidence that in the Swedish market, with different tick sizes in each share, tick size has significant influence on bid-ask spread. This previous academic evidence implies that the results of this study might provide evidence of narrower spreads and smaller depths for two reasons. First of all, spreads are likely to be relatively smaller in Helsinki Stock Exchange since quoting of them is technically possible. Secondly, since this study includes all the orders in order book, the expected larger amount of small orders is likely to reduce the quoted spreads and depths even further.

Another characteristic relating to a relatively small tick sizes in Helsinki Stock Exchange is price-internal-time priority. According to the price-internal-time priority, order with the best price is always matched first. However, if there are two or more orders on a same price level, Helsinki Stock Exchange favors internal orders, instead of prioritizing time, as it is commonly the case. This rule inevitably favors larger market participants, with both private customers submitting online orders as well as traders executing large orders. One of the main arguments for this rule is the fact documented by Goldstein and Kavajecz (2000) that smaller tick sizes favor smaller market participants. Another argument for this prioritizing is that large members could always keep part of their orders

¹ None of the companies in this study used liquidity providing.

in their internal order book and wait if they can match these orders internally¹. Since price-internal-time priority guarantees members that their own orders are favored they ought to be more willing to provide more liquidity and thus improve market transparency.

Another specialty in Helsinki Stock Exchange is the abolishing of odd-lot trading, in September 2006. Before the change, round lots in Helsinki Stock Exchange varied from 10 to 1000 shares, while after the change minimum unit of trading for all equities listed in Helsinki Stock Exchange has been one share. Unfortunately, the effects of abolishing the odd-lot trading are relatively little investigated. When Australian Stock Exchange conducted similar amendment to their market model two of the biggest arguments were that the move would lead to reduced trading costs, particularly for small shareholders and that this would in turn encourage investors to trade their odd lots, thereby increasing liquidity. On the other hand, the Odd Lot Specialist (OLS) argued that there would be a reduction in market efficiency as the effective market-making role that the OLS had been performing, particularly in the smaller stocks, would disappear, making it harder for such trades to be executed.

The evidence provided by Australian Stock Exchange after the change was mixed². Consistent with OLS-traders arguments the trading with “true odd-lots” (amounts smaller than previous odd-lots), in effect became more expensive as trading with “true odd-lots” decreased 88% after the change. However, the trading with uneven trading proportions larger than “true odd-lots” increased dramatically bringing total net liquidity up by \$30 million in the six months post the change. Interestingly, evidence provided by Australian Stock Exchange does not find any support that the bid-ask spread would have decreased after the change.

¹ Reporting internal contract trades has traditionally been cheaper than trades conducted in order book. After the MIFID regulations came into force 1st of November 2007 this difference is even larger.

² <http://www.sirca.org.au/Papers/1997002.pdf>

3. Previous Research and Hypotheses

3.1. Earnings Announcements, Volatility and Abnormal Returns

Obviously one of the first questions relating to the earnings announcement has been, whether an individual monitoring earnings announcements can earn excess returns by trading on the sign of the of the earnings forecast error. Francis, Pagach and Stephan (1992) examined price and volume reaction to overnight and day time announcements of 558 NYSE listed companies. They provide evidence that due to the absence of an opening reaction to overnight announcements, investors who submit a market buy (sell) order prior to the open based on the sign of the forecast error earn a cumulative excess return of approximately 1.4% by the close of day +2 relative to the announcement day. However, as authors point out such strategy is unlikely to be profitable once transaction costs are included.

Kalai and Loewenstein (1985) were the first to document positive excess returns around dividend announcements. They hypothesized that the risk per unit of time and the required rate of return are higher than normal during an event period whose timing can be predicted. They investigated 20,451 dividend announcements for the period of July 1962 to December 1980 and found out that the unconditional mean rate of return, the variance of stock returns and their systematic risk are higher than usually during dividend announcement periods. Authors point out that the documented increase in the systematic risk is not large enough to fully explain the excess returns.

Bajaj and Vijh (1995) examined further the price formation process during dividend announcement day. Using daily closing prices and transactions data of 67 592 dividend announcements by NYSE listed firms the authors documented a 0.21 percent average excess return over the three-day announcement period. Bajaj and Vijh (1995) examination of trade prices relative to the bid-ask spread and volume of trades at bid and ask prices showed that these excess returns cannot be attributed to measurement errors or

to spillover effects of tax-related ex-day trading. Rather, the price behavior is related to the absorption of dividend information.

Ball and Kothari (1991) examined risks, returns and abnormal return behavior around 51,178 quarterly earnings announcements of NYSE and AMEX listed companies. They hypothesized that return variances and betas, and therefore expected returns, increase during earnings announcement periods and argued that since risk was not allowed to vary in event time, previous research was not adequately able to distinguish between increased expected returns and true abnormal returns. Authors report 0.24 percent excess return on earnings announcement dates, after controlling for risk increases at earnings announcements.

Cohen, Dey, Lys and Sunder (2007) brought Ball and Kothari (1991) findings under review. Authors argued that much has changed since their research; the disclosure environment is richer with more frequent and detailed voluntary disclosures, such as earnings guidance, preannouncements, and conference calls. Therefore, earnings announcement premia should have decreased since there is more frequent resolution of uncertainty preceding the earnings announcement. Authors also point out several issues likely to contribute to the increased announcement-period variance, such as increased noise trading, greater news flow, decreased quality of earnings, and increased dispersion in analysts' forecasts. Cohen, Dey, Lys and Sunder (2007) report that the premia continues to persist beyond the period studied by Ball and Kothari (1991). They found that while on average, the variance of the announcement-period abnormal returns increases significantly from 0.031 in the 1980–1988 period to 0.047 in the 1989–2001 period, there is a significantly smaller increase in announcement-period return variances for firms that preannounce earnings.

Campbell, Lettau, Malkiel and Xu (2001) point out that it is by now a commonplace observation that the volatility of the aggregate stock market is not constant, but changes over time. They document using monthly data from 1926 to 1997 that market volatility has no significant trend and that market and industry variances have also been fairly

stable during the period ranging from 1962 to 1997. However, firm-level variance displays a large and significant positive trend, more than doubling between 1962 and 1997. Campbell et al. (2001) suggest a number of possible explanations for this phenomenon including increasing leverage, higher incidence of spin-offs of conglomerates, firms issuing stocks earlier in their lifecycles and increase in option-based compensation.

Motivated by Campbell et al. (2001), Rajgopal and Venkatachalam (2005) explored whether deteriorating of financial reporting quality can plausibly explain the increase in idiosyncratic volatility over the period from 1962 to 2001. Authors used two proxies for capturing reporting quality: earnings quality (proxied by Dechow-Dichev (2002) measure of earnings quality and the absolute value of abnormal accruals) and analyst forecast dispersion. They document that earnings quality has deteriorated over the last 40 years and dispersion in analysts' forecasts of earnings has also increased considerably over that period. Furthermore, authors provide evidence that these trends in earnings quality and dispersion in analyst forecasts exhibit a strong positive statistical association with the time-trend in return volatility and that this positive association persists even after controlling for newly listed firms and after accounting for technology-intensive firms and firm-year observations with negative earnings, merger activity and financial distress.

3.2. *Stock Price Adjustment*

The speed at which securities prices adjust to new information have been studied extensively. Academic literature includes studies on securities prices after the disclosure of; earnings announcements (Ball and Brown 1968), analysts buy and sell recommendations (Womack 1996), open market share repurchases (Ikenberry, Lakonishok, and Vermaelen 1995), large block trades (Dann, Mayers, and Rabb 1977) and dividend changes (Patell and Wolfson 1984). Jennings and Starks (1985) found that price reaction after the earnings announcement differs between low and high degree of new information releases and in their follow-up study Jennings and Starks (1986) found

that the price reaction also differs depending on whether the company is traded on the option markets or not.

In their study Ball and Brown (1968) noted that after the earnings are announced, estimated cumulative abnormal returns continue to drift up for “good news” companies and down for “bad news” companies. This post-earnings-announcement drift is subsequently identified by several other researchers, including Foster, Olsen, and Shevlin (1984), Watts (1978) and Rendleman, Jones, and Latane (1982). Patell and Wolfson (1984) examined the effects of earnings and dividend announcements on the intraday behavior of stock prices. Their results indicated that the earnings announcements were associated with large increases in the variance of intraday returns which persist for up to four hours after the disclosure. Dividend announcements, as a class, did not appear to induce large increases in the intraday price change variance, but significant disturbances were detected at the announcement of dividend changes. In a related study, Jennings and Starks (1985) estimated relative degrees of information content of earnings reports by the changes in investor beliefs about future earnings. They measured changes in investors' beliefs by the revisions of financial analysts' forecasts of fiscal year-end earnings in response to interim earnings reports. Their results indicated that earnings reports with higher than average information content lead to an adjustment process which both begins before and extends beyond the adjustment process associated with reports with lower than average information content.

Foster, Olsen, and Shevlin (1984) constructed two alternative approaches to analyze the post-announcement behavior of stock returns. The first is the earnings-based model (EBM) approach, similar model to Ball and Brown (1968), which assigned companies into deciles based on standing of standardized unexpected earnings. The second approach assigned firms to portfolios on the basis of firms' estimated abnormal stock returns over the 60 days prior to and including the earnings announcement day. This was labeled as the security-return model (SRM) approach. Authors document that the essential difference between the two models is that while post-announcement drift was observed under the EBM approach, there is no indication of post-earnings-announcement drift

using SRM tests. Foster, Olsen, and Shevlin (1984) argue that their results could suggest that the drift in the EBM tests reflects a premium for some unidentified risk. In their empirical part Bernard and Thomas (1989) show that if (1) there exists some delay in the response to earnings news, and (2) the fraction of the total response that is delayed varies sufficiently across firms, then it is possible simultaneously to detect a drift in the EBM tests but not detect a drift in the SRM tests. Bernard and Thomas (1989) conclude that much of their evidence cannot plausibly be reconciled with arguments built on risk mismeasurement but is consistent with a delayed price response.

Bernard and Thomas (1989) point out two alternative explanations for post-earnings-announcement drift: at least a portion of the price response to new information is delayed or that abnormal returns observed are nothing more than fair compensation for bearing risk that is priced but not captured by the Capital Assets Pricing Model (CAPM). Widely accepted critique for CAPM concentrate on its key assumptions; homogeneous expectations, normally distributed returns, investors risk neutrality and no taxes and transaction costs. Roll (1977) argues that CAPM might not be empirically testable since it requires the determination of market portfolio. Market portfolio should in theory include all types of assets that are held by anyone as an investment (including works of art, real estate, human capital...) and since the true market portfolio cannot be observed it is in practice often replaced by stock market index. Roll (1977) argues that using a proxy for the market portfolio is subject to two difficulties. Firstly, proxy itself might be mean-variance efficient even when the true market portfolio is not. Secondly, the chosen proxy may turn out to be inefficient; but obviously, this alone implies nothing about the true market portfolio's efficiency.

Bernard and Thomas (1989) makes a case for delayed price response by arguing that traders may fail to assimilate available information, or because certain costs (such as the costs of transacting or the opportunity costs of implementing and monitoring a trading strategy) exceed gains from immediate exploitation of information for a sufficiently large number of traders. Authors find that the drift appears to be "constrained" by an upper bound that is approximately equal to roundtrip transactions costs for the individual

investor and that this bound varies across firm size in the same way transactions costs do. However they do not find strong evidence that abnormal returns to short positions in bad news stocks exceed the abnormal returns to long positions in good news stocks, as would be predicted if restrictions on short sales play a role in causing the drift. Moreover, they also find that much of the drift is concentrated around the next quarter's earnings announcement and argue that this finding is difficult to explain except as a reflection of market prices that fail to recognize fully the extent of serial correlation in seasonally differenced quarterly earnings.

Manaster and Rendleman (1982) suggested that option trading may improve market efficiency. They argued that if some traders believe the option market provides a superior investment vehicle (because of transactions costs, leverage, liquidity, or short sales restrictions), they may execute their investment strategies using options as a substitute for or supplement to stock positions. These option markets "plays" may move option premia out of equilibrium relative to the underlying stocks' prices. If the premia become far enough "out of line," arbitrageurs intervene to realign stock and option prices. Thus, the option market may play an important role in determining equilibrium stock values. Manaster and Rendleman (1982) tested and rejected the hypothesis that the equilibrium stock prices implied by option premia provide no information regarding future stock price movements. Jennings and Starks (1986) found that the stock prices of non-option firms take longer to adjust to earnings announcements than the prices of control portfolios of option firms. This supported their argument that the existence of the option market is useful in disseminating earnings news.

Woodruff and Senchack (1988) extended the previous work by analyzing the speed and time of stock price adjustment as well as investigating trading volume, transaction frequency and transaction size. Their results indicated, at least in modern standards, a relatively long average of fourteen minutes between the announcement and first trade. In addition, they found differences in the adjustment process of high- versus low-informational-content announcements and that those stocks with extremely favorable earnings surprises exhibited a more rapid adjustment than those with extremely

unfavorable unexpected earnings. They also documented that the companies with extreme earnings surprises typically had a small market capitalization, low institutional ownership and no tradable options.

Delayed reaction to an analysis of new buy and sell recommendations of stocks by security analysts at major U.S. brokerage firms is also observed by Womack (1996). He documents a modest and short-lived, mean post event drift of +2.4% for buy recommendations, but for sell recommendations, the drift is larger (-9.1%) and extends for six months. Womack (1996) draws three conclusions from his empirical results. First, the immediate reactions to recommendation changes appear to be permanent, not quickly mean-reverting. Second, the drift results remain mostly an unsolved puzzle. They contribute to a category of findings showing initial under reaction and subsequent drift associated with significant informational events such as earnings announcements, stock repurchases, and dividend initiations and omissions. Third, new buy recommendations occur seven times more often than sell recommendations, suggesting that brokers are reluctant to issue sell recommendations.

Ikenberry, Lakonishok, and Vermaelen (1995) examine long-run firm performance following open market share repurchase announcements during 1980-1990. They document abnormal returns associated to share repurchase announcements of "value" companies, measured by their book-to-market ratio. However, not all studies have documented slow adjustment of securities prices to the new information. Dann, Mayers, and Rabb (1977) found that unless one could purchase the stock within five minutes of the block trade the profitability of the buy and sell at close strategy could not produce any abnormal returns. They document the market price to be an unbiased estimate of the closing price within 15 minutes of the block trade.

3.3. *Management, Analysts and Earnings Announcements*

Chen and Mohan (1994) focus on the psychological aspects of the earnings announcements arguing that management has incentive to manipulate earnings announcement timing if a longer reporting lag provides more opportunity for investors to absorb information in order to avoid a panic response to the official announcement. Authors' report that companies are more likely to change announcement date, than announcement time and that smaller companies are more likely to alter their announcement schedule. Furthermore, they find evidence that lower than expected earnings are more likely to concern firms more and that they are thus more likely to release them earlier than higher than expected earnings.

Gennotte and Truman (1996) examine two aspects of firms' disclosure policies, intraday timing of earnings announcements and sequencing of multiple corporate disclosures. They demonstrate that, under reasonable conditions, market prices reflect better the valuation implications of an earnings announcement when it is made during trading hours rather than after the market has closed. This implies that managers should prefer to release earnings with positive (negative) implications for firm value during (after) trading hours. Furthermore, authors provide evidence that if the announcements have positive (negative) implications for firm value, managers should prefer to make them separately (simultaneously), as market prices better reflect the valuation implications of multiple announcements when they are made at different times.

Lang and Lundholm (1996) investigated cross-sectional variation in analysts' published evaluations of firms' disclosure practices. They hypothesize that forecast dispersion, standard deviation of the consensus EPS forecast, can be attributed to either differences in the private information possessed by analysts or differences in the forecasting models employed by analysts. Authors find that firms with more informative disclosure policies generally have less dispersion in analyst forecasts, lower levels of revision volatility and more extensive analyst coverage. Moreover, Atiase and Bamber (1994) and Lobo and Tung (1997) provide evidence that firms with higher levels of pre-disclosure information

asymmetry, as reflected by the dispersion in analyst forecasts, have higher equity trading volume when earnings are announced.

Kanagaretman, Lobo and Whallen (2005) investigate the relationships between three variables which proxy for the ex-ante level of information asymmetry – forecast dispersion, forecast revision volatility, and the level of analyst coverage, and equity bid-ask spread and depth changes around quarterly earnings releases. They document that relative spreads have a significant positive relation with both forecast dispersion and revision volatility and a significant negative relation with analyst coverage, while relative depths have a significant negative relation with forecast dispersion and a significant positive relation with analyst coverage.

Bamber (1987) document that both the magnitude and duration of the trading volume reaction to quarterly earnings announcements are increasing functions of unexpected earnings and decreasing functions of firm size, a likely factor affecting the availability of pre-disclosure information. Vieru (2002) finds evidence that the change in intraday trading behavior is associated with announcement-related factors, such as the range of analysts' earnings forecasts, the magnitude of unexpected earnings and firm size.

3.4. Trading Behavior and Earnings Announcements Studies in Finland

The high quality data available in Finland have inspired several studies to investigate investors trading patterns. Grinblatt and Keloharju (2001) show that past returns, reference price effects, the size of the holding period capital gain or loss, tax-loss selling, and, to a small extent, the smoothing of consumption over the life cycle all are determinants of trading. Linnainmaa (2003) concentrates on day traders and show that realized results of day traders are high, but these results are not representative of overall performance, because of day traders' strong reluctance to realize losses. Linnainmaa (2003) also provides evidence that day traders prefer to trade in stocks they already own, have day traded before, or that have experienced high excess returns during the previous trading sessions. Furthermore, Grinblatt and Keloharju (2008) provide evidence that

sensation seeking and overconfidence are unrelated attributes that increase investors trading activity.

Hedvall (1994) was the first to document U-shape trading pattern, heavy trading in the beginning and at the end of the trading day and relatively light trading in the middle of the day, in Finland. Vieru (2002) used a sample of Helsinki Stock Exchange listed companies between 1992 and 1996, and studied the quarterly earnings announcements effects to U-shape trading pattern. He founded that before the announcement day trading is more concentrated at the close, indicating investor's willingness to bear expected overnight risk before the announcements as he did not observe similar statistically significant increase in the amount of transactions. In related studies, Martikainen, Kallunki and Perttunen (1997) found that unexpected accounting losses are not significantly related to stock returns in Finland, and Schadewitz (1997) examined the determinants and implications of the information disclosed in interim reports in the period of 1985 – 1993 on Helsinki Stock Exchange.

Vieru, Perttunen and Schadewitz (2006) focused on non-institutional trading behavior around interim earnings announcements in Helsinki Stock Exchange. They document that earnings announcement triggers trading in every five household classes in their sample and that actively trading individuals show increased buying and selling activity before the event compared to non-event period. They also found that Finnish households in the most active class tend to follow contrarian strategy, especially selling after good news which supports the earlier evidence of Grinblatt and Keloharju (2001) that investors have tendency to sell winners too early.

3.5. *Order Book Spread, Depth and Information Asymmetry*

Existing market microstructure literature shows that the quoted bid-ask spread consists of three components: order-processing costs, inventory-holding costs, and adverse selection costs. The order-processing cost represents a fee charged by market maker for standing

ready to match buy and sell orders (Tinic 1972). The Inventory holding cost component compensates dealers for managing the inventory (Stoll 1978, Ho and Stoll 1981). The adverse selection component represents a reward to specialists for taking on the risk of dealing with traders who may possess superior information (Copeland and Galai 1983, Glosten and Milgrom 1985).

In their theoretical work Glosten and Milgrom (1985) assume two types of traders: "informed" traders and "liquidity" traders. Informed traders trade because they have private information not currently reflected in prices, while liquidity traders trade for reasons other than superior information. Glosten and Milgrom (1985) argue that specialists sustain losses from trading with informed traders, and recover these losses through the bid-ask spread against liquidity traders. Although they do not claim that adverse selection is the sole source of bid-ask spread they argue that greater information asymmetry between informed and liquidity traders will lead to wider spreads.

Lee, Mucklow and Ready (1993) note that bid-ask spread is only one dimension of market liquidity. They point out that, if the specialist believes the probability that some traders possess superior information has increased, he may respond by increasing the bid-ask spread. Alternatively, the specialist could protect himself by quoting less depth (offering to trade less at each quoted price). Lee, Mucklow and Ready (1993) show that in theory the combination of wider (narrower) spreads and lower (higher) depths is sufficient to infer a decrease (increase) in quoted liquidity.

In their empirical part, Lee, Mucklow and Ready (1993) investigated 230 NYSE listed companies between January 1988 and December 1988. They discovered that spreads widen and depths drop in response to increase in trading volume. They suggest that these results interpreted in context of Easley O'Hara (1992) model suggest that liquidity suppliers use increased volume to infer the presence of informed traders. In their second part, the authors investigated specialist response to earnings announcements. They document that spreads widen and depth decrease before the earnings announcements and that the magnitude of this liquidity drop is positively related to the magnitude of

subsequent price reaction. Furthermore, Lee, Mucklow and Ready (1993) document that spreads increased after an earnings release and that the sharpest increase in both effective and quoted spreads occur in the half-hour containing the announcement. However, while they show that the increase in spreads continues for at least one trading day after the announcement, the depths revert to normal levels within three trading hours.

Kavajecz (1999) extends the work of Lee, Mucklow and Ready (1993) by providing evidence that both specialists and limit order traders reduce depth around information events, thereby reducing their exposure to adverse selection costs. He documents that specialists change their quoted depth in 90 percent of all quote changes and that 50 percent of all quote changes are unaccompanied by changes in quoted prices. Kavajecz (1999) results show that specialist's quotes may reflect only the limit order book on the side (or sides) of the market maker believe there is a chance of informed trading.

Dupont (2000) investigates the relationship between specialist quoted depth and spread in theoretical framework with a risk-neutral, monopolistic market maker who faces a price-sensitive liquidity trader and a risk-neutral or, alternatively, risk averse informed trader. He shows that a monopolistic, risk-neutral dealer narrows his depth proportionally more than he widens his spread to respond to an increase in the degree of information asymmetry. Furthermore, Dupont (2000) provides evidence that the elasticity of substitution between the depth and the spread with respect to the quality of the informed trader's information depends on market conditions, which are characterized by the information asymmetry, the volatility of the asset, and the strength of liquidity demand. He argues that this elasticity approaches infinity when market conditions become either extremely favourable (the depth expands to infinity while the spread remains positive) or extremely unfavourable (the depth contracts to 0 while the spread remains finite).

It is unclear to what extent these cost components define the bid ask-spread. Stoll (1989) examined the relative importance of the quoted spread. He argues that while the quoted spread varies considerably across stocks, the components of the spread appear to be an invariant proportion of the quoted spread. On the basis of the empirical estimates of Stoll

(1989), the quoted spread, S , may be decomposed into the following three components; adverse selection component $0.43S$, inventory holding cost $0.10S$ and order processing costs $0.47S$.

Brockman and Chung (1999) investigated the timing of open market share repurchases and the resultant impact on firm liquidity in Hong Kong Stock Exchange between November 1991 and August 1999. They use managers as a proxy of informed investor and show that managers outperform an uninformed strategy in every year of their sample using conventional levels of significance. Furthermore, their results show that at the time of execution, market participants detect the presence of informed trading and respond to the consequent rise in adverse selection by reducing the overall firm liquidity. This suggests that adverse selection cost components may form large proportion of total bid-ask spread. Bloomfield (1996) examined the behavior of laboratory markets in which two uninformed market makers compete to trade with heterogeneously informed investors. His results support the existence of adverse selection cost component, but also provide evidence that inventory holding cost component may have high effect on quoted bid-ask spread. Although the order processing costs (exchange and clearing fees, book keeping, back office costs and market makers time and effort) usually raise less attention among academics their existence is also evident. However, since many of these costs are fixed, order processing costs, as a percentage of total costs, ought to be lower from more heavily traded securities.

Kim and Verrecchia (1994) modeled how information asymmetry affects the trading around earnings announcements. They suggested that there may be more information asymmetry at the time of an announcement than in non-announcement periods. In their model some market participants process earnings announcements into private, and possibly diverse, information about a firm's performance at some cost. This private information can be thought of as informed judgments or opinions. Market participants who provide informed judgments are those traders willing to bear the cost for engaging in this activity. In the absence of announcements there are no opportunities for traders capable of informed judgments to exploit their ability to process public information. This

lessens the possibility of information asymmetries arising. Alternatively, earnings announcements stimulate informed judgments. These informed judgments, in turn, create or exacerbate information asymmetries between traders and market makers. This implies that the market becomes less liquid as a direct consequence of more disclosure.

Furthermore, Kim and Verrecchia (1994) argue that the diminished liquidity does not itself imply less trading activity around public announcements. While discretionary liquidity traders will avoid these periods, traders who process public information face a more subtle trade-off. They choose between being relatively well-informed and trading in relatively illiquid markets versus being relatively uninformed and trading in liquid markets. Investors capable of processing publicly available information prefer the former because the price quotations of market makers in illiquid markets only partially offset the advantage of being well-informed.

Empirical studies on information asymmetry have produced mixed results. Morse and Ushman (1983) and Skinner (1991) find no significant increase in bid-ask spreads around earnings announcements. Brooks (1996) argues that the bid-ask spread is a function of execution and inventory costs as well as adverse selection costs and unless decomposed, the quoted spread is a noisy proxy for the level of information asymmetry. His results show that the level of information asymmetry falls at the earnings announcement and that many traders postpone their trading until after the earnings announcements, based on the fact that trading volume increases on announcement day and remains significantly higher for next two days. Brooks (1996) concludes that the earnings announcements reduce the level of asymmetric information among traders. Yohn (1998) finds that bid-ask spreads are negatively related to public information availability and positively related to earnings variability and the market reaction to prior unexpected earnings. She documents that bid-ask spreads gradually increase in the four days prior to earnings announcements, and increase sharply the day prior to, the day of and the day after the earnings announcements.

Nevertheless, as discussed earlier in this chapter Lee, Mucklow and Ready (1993) point out that the liquidity consist of not only the bid-ask spread but also the depth. They show that spreads widen and depths fall before the earnings announcements and in response to higher volume. Libby, Mathieu and Robb (2002) analyzed a sample of 235 TSE listed companies using half-hour intervals around earnings announcements. They document that specialist depth around earnings announcement is smaller than during non-announcement period. They also provide evidence that spreads are wider before the earnings announcement, but fail to provide statistically significant evidence of wider spreads after the earnings announcement. Further support for their findings is provided by Krinsky and Lee (1996), who analyze the bid-ask spread components and find that asymmetric information increases in the equity market prior to and following earnings releases.

Based on Kim and Verrecchia (1994) argument that information asymmetry increases around earnings announcements, and empirical evidence of Lee, Mucklow and Ready (1993) and Libby, Mathieu and Robb (2002), my first hypothesis is,

Hypothesis I: In the period just before earnings are announced (the pre-announcement period), quoted spreads will be wider and quoted depths will be lower than in the non-announcement period. This effect is expected to persist into the period just after earnings are announced (the post-announcement period).

3.6. *Quarterly versus Annual Earnings Announcements*

The prior academic literature argued that there exists one notable way on which quarterly and annual earnings announcements differ from each others. The figures of annual earnings announcements are audited, while auditors do not have obligation to audit figures published in quarterly earnings announcements. Thus, interim earnings numbers may contain more noise due to errors, omissions, or poor estimates (Jones and Publitz (1990), Mendenhall and Nichols (1988) and Givoly and Ronen (1981)).

The differences in market reaction between annual and quarterly earnings announcements have been widely researched. Kross and Schroedder (1990) suggested and found evidence that difference between the information content of quarter and annual earnings announcements would exist only for small firms. They argue that accounting information is subject to continuing auditing and monitoring, so differences between quarterly and annual earnings reports would be small. Mendenhall and Nichols (1988) argue that managers have greater discretion over interim than annual earnings reports and may use this discretion to delay bad news until the end of the year. Consistent with their hypothesis they report that quarterly earnings reports that miss expectations have a significantly larger per-unit effect on risk-adjusted security returns than bad news earnings announced in the fourth quarter. Moreover, Cornell and Landsman (1989) report evidence that annual earnings announcements convey more information than quarterly earnings announcements.

While the academic research has provided evidence on differences between annual and quarterly earnings announcements, the underlying legislation has also changed. In accordance to international trend interim reports have become mandatory, while the content of them is more strictly regulated. Vieru, Perttunen and Schadewitz (2006) document that in 1997 only about 20 percent of HSE-listed companies published three interim reports, while the corresponding number in 2000 was 70 percent. Today the rule 3.2.15 of Helsinki Stock Exchange requires listed companies to disclose three interim reports no later than two months after the end of each interim period. Moreover, according to the Rules of the OMX Nordic Exchange Helsinki¹, listed companies must disclose any audit reports issued on their accounts, annual financial reports and corporate governance immediately upon issue if the auditors deem that any of the interim reports published by the company during the financial reporting year have not been prepared in compliance with applicable regulations. This suggests that companies must obey high standards with quarterly and annual reports alike, since the auditors have obligation to monitor the content of the quarterly earnings announcements.

¹ Rules of the Stock Exchange Chapter 3, Section 2, Paragraph 22, Moment 4

While the bid-ask spread and depth have been investigated in relation to the new information, Libby, Mathieu and Robb (2002) have been one of the first to apply intraday trading data to investigate the difference in market reaction after annual and quarterly earnings announcements. They argue that, when the precision of the signal is lower, as may be the case for quarterly earnings announcements, less information asymmetry is resolved. Consequently, specialists will set lower depths than would be set around the announcement of more precise annual earnings news. Libby, Mathieu and Robb (2002) hypothesized that relative spread will be wider and relative depths will be lower before the announcement of quarterly earnings report than before the announcement of annual earnings report.

In their research Libby, Mathieu and Robb (2002) investigated quarterly and annual earnings announcement effects to specialist relative depth, relative spread and volume. They document that the depth offered by specialist is statistically significantly smaller than during non-announcement period right before the disclosure of earnings announcement. Their further analysis reveals that smaller depth offered by specialist during this period is predominately driven by quarterly earnings announcements. They argue that this finding suggests that the specialist perceives the change in the information risk due to quarterly earnings announcements as different from the change due to annual earnings announcements.

Interestingly, Libby, Mathieu and Robb (2002) document that trading volume before the disclosure of earnings announcement is statistically significantly larger than during non-announcement period. This observation is driven by earnings announcements disclosed during trading hours and particularly by quarterly earnings announcements. Nevertheless, authors are forced to discard their hypothesis since their research on specialist quoted spread does not adequately support their hypothesis. Based on Libby, Mathieu and Robb (2002) inconclusive evidence that quarterly and annual earnings announcement differ from each others, I aim to tackle this subject equipped with a few additional variables such as volume weighted spread and liquidity. Based on existing regulation, which controls the quarterly earnings announcement by leaving managers less discretion over

accounting choices, I do not expect to find significant differences in information processing between annual and quarterly earnings announcements. Therefore my second hypothesis is:

Hypothesis II: There is no difference between relative spreads and relative depths before the disclosure of quarterly earnings announcement and before the disclosure of annual earnings announcement.

3.7. *Intraday Timing of Earnings Announcements*

Francis, Pagach and Stephan (1992) lists several reasons why market reaction to daytime and overnight announcements may differ: (1) day time announcement tends to contain more positive news than overnight announcements; (2) investors may not be willing to submit full orders before they observe the new market price; (3) the price determination process during continuous trading and auction differs; (4) “chaotic traders” may not be active participants after overnight announcements; (5) most of the stock exchanges’ discourage large price movements through technical limitations; (6) the opening price in the opening auction consist of both pre- and post announcement orders and may not thus fully reflect the value of the new information. Francis, Pagach and Stephan (1992) suggest that only the first one of their arguments indicates that the response to overnight announcement is speedier.

The saying, “when the news is bad, put it out on Friday night and hope it gets lost by Monday morning” may not be completely true, but nevertheless carries some wisdom in it. Chen and Mohan (1994) argue that a longer lag between disclosure and first trade provides investors opportunity to absorb information in order to avoid a panic response to the official announcement and thus provides motivation for the timing of the earnings announcement. Accordingly, Patell and Wolfson (1982) provide evidence that overnight announcements tend to contain more bad news and more big surprises than daytime disclosures. Further motivation for managers to delay the disclosure of the earnings

announcements to non-trading hours provides Woodruff and Senchak (1988), who shows that the market responds more quickly to favorable than to unfavorable earnings surprises and Jennings and Starks (1985), who found some evidence that the market response to big surprises begins sooner and lasts longer than the reaction to small surprises. However, if overnight disclosures are more likely to contain large, negative earnings surprises, the two effects may offset. It is not obvious, however, whether one effect dominates, as Francis, Pagach and Stephan (1992) notes.

Secondly, the information dissemination process of daytime and overnight earnings announcements may differ. Overnight earnings announcements are typically disclosed early in the morning or late in the evening, in both cases well ahead of the opening auction. Kim and Verrecchia (1994) argued that information asymmetry raises around disclosure of earnings announcements as some investors are able to process earnings announcement into private information about firm's performance. If the announcement is disclosed before the continuous trading, more investors are able to analyze and interpret the earnings announcement. Genotte and Trueman (1996) point out that if the earnings announcement is disclosed outside trading hours there is more time for orders from noise traders to accumulate. Therefore, the post-announcement price is less likely to reflect the information of the informed traders if the earnings announcement is disclosed outside trading hours.

Grossman and Stiglitz (1980) and Jordan and Radner (1982) point out that the day time earnings announcement returns reflect the demands of traders who become informed by observing transaction prices. According to Francis, Pagach and Stephan (1992), traders, especially those trading large amounts of stock, do not typically submit their entire order at the open following an overnight disclosure. Instead, they submit a partial order and wait for the opening to decide how to proceed. On the other hand partial opening orders may also be due to investors' reluctance to affect market prices, since large buy (sell) order will increase demand (supply) and thus reveal the investors intentions.

Thirdly, due to the market functionalities the first post announcement trade following overnight announcement represents a batching and execution of many orders, whereas the first post announcement trade following the day time announcement represents the execution of only one order (Pronk 2006). Trader familiarized with this market functionality can submit a reasonably sized order, relative to normal auction turnover of that share, which is far better than the prevailing market price, because he knows that he is able to buy (sell) his shares at the equilibrium price of the auction. However, during the continuous trading, similar sized order, with a limit far off from the prevailing market price may become very expensive for the investor as he might have to pay close to the limit price for most of his shares.

Fourthly, Francis, Pagach and Stephan (1992) point out the existence of "chaotic traders". Chaotic traders know that information has been released but are not particularly well informed about its nature. While more cautious investors read and interpret the news item and formulate a trading strategy, chaotic traders attempt to make short-term profits by creating and reversing positions within minutes of a news wire report. A related classification was developed by Copeland and Galai (1983) and Glosten and Milgrom (1985), who discuss two types of traders: "informed" traders and "liquidity" traders. Informed traders trade because they have private information not currently reflected in prices, while liquidity traders trade for reasons other than superior information. The overnight earnings announcements diminish the possibilities for chaotic and liquidity trading strategies, because they reduce information asymmetry between investors due to the protracted information dissemination period.

In the aftermath of Black Monday, in 19th of October 1987, many stock exchanges started to impose technical limitations to prevent sudden large price movements. These arbitrary limits may restrict the price development in particularly after overnight announcement when the last comparable price is the yesterday's closing price and because the price reaction after the day time announcement usually happen in several steps. Among the most commonly used technical limitations are circuit breakers, collar rules and price limits. Circuit breakers provide for a brief coordinated trading halt if the security or

index, in case of market wide trading halt, breaches some predetermined barrier such as $\pm 5\%$. The most widely known collar rule is New York Stock Exchange Rule 80A, according to which if the DJIA moves up or down two percent (2%) from the previous closing value, program trading orders to buy or sell the Standard & Poor's 500 stocks as part of index arbitrage strategies must be entered with directions to have the order executions effected in a manner that stabilizes share prices. Price limits, on the other hand, do not halt the trading, but prevent investors from entering orders that deviate too much from yesterday's closing price or last paid price.

The maximum validity period for orders in the equities market varies from about week to 90 days depending on exchange policies. Therefore it is very likely that when the earnings announcement is disclosed order book will consists of both uniformed (pre-announcement) and informed (post-announcements) orders. Assuming immediate price reaction to daytime earnings announcement, it is possible that these long validity orders would have been revoked, had the investor known about the announcement. Although the same applies to overnight earnings announcements, investors nevertheless have more time to cancel or amend their orders since the trading does not start immediately.

In their empirical part, Francis, Pagach and Stephan (1992) investigate the price and volume reactions to overnight and daytime earnings announcements made by the same firm in adjacent years, but find no evidence that the opening trade reflects overnight announcement information. Authors argue that this is mainly due to the investors' reluctance to submit their full orders following an overnight announcement. Contradicting evidence is provided by Greene and Watts (1996) who show that the opening trade after overnight earnings announcement impounds most of the price response in both NYSE and NASDAQ. Furthermore, Greene and Watts (1996) document that in NYSE the price adjustment of trading hours earnings announcements is spread evenly over the first several post-announcement trades, whereas on NASDAQ the price adjustment is concentrated on the first post-announcement trade.

Recent results on this subject are mixed. Pronk (2006) studied 2,802 overnight and daytime earnings announcements disclosed by NYSE and AMEX listed companies. He finds that daytime releases relate, on average, to significantly larger percentage deviation in spread and a smaller deviation in depth. He is able to show that his results are robust even after controlling whether overnight announcement occurs after before-open and after-close announcements, suggesting that additional time available to analyze the announcement does not significantly alter the information processing. He suggests that his results could at least partly be related to differences in market microstructure between the exchanges.

Pronk (2006) evidence was in contradiction to Libby, Mathieu and Robb (2002) who studied companies listed in the Toronto Stock Exchange. Libby, Mathieu and Robb (2002) find that specialist reacts differently to earnings announcements disclosed outside trading hours than those disclosed during trading hours. They document that depths are smaller and statistically significant than during non-announcement period for overnight earnings announcements, while fail to provide statistically significant evidence on positive depth after earnings announcement disclosed during the continuous trading. For the spread, Libby, Mathieu and Robb (2002) reject their null hypothesis of no difference in relative spreads when earnings are announced during as compared with outside trading hours at 10 percent level for full sample and quarterly announcement subsample.

Based on Francis, Pagach and Stephan (1992) arguments I expect to find that the information asymmetry will be solved faster once the earnings announcement is disclosed during continuous trading. This should be observed as relatively smaller spreads and relatively higher depths after daytime earnings announcements.

Hypothesis III: Relative spreads will remain wider and relative depths will remain lower for a longer period of time when earnings announcements occur outside trading hours than when they occur during trading hour

4. Data

The earnings announcement data consists of 338 quarterly and annual earnings announcements of the 32 companies, which have belonged to OMXH25-index between December 1st 2004, and August 31st 2007. Although the amount of earnings announcements used in prior papers is more impressive, this study is limited to the most liquid shares in order to capture earnings announcement effects to order book thoroughly. The earnings announcements, as well as the exact times they were disclosed into the trading system and distributors' were acquired from the Nordic Exchange Helsinki databases.

Following EU regulations to liberalize the distribution of stock exchange announcements Helsinki Stock Exchange launched a new Company News Service (CNS) system on 19th of February 2007. Before that, Helsinki Stock Exchange had a monopoly to disclose all the stock exchange announcements released by the companies¹. The earlier stock exchange announcement system allowed companies to disclose information only between 7:45 am. and 7.00 pm., while the current system is open 24 hours a day. Since companies have rarely used the option to disclose stock exchange announcement during these new opening hours, no sample bias is expected.

Trading day in the Helsinki Stock Exchange can be divided into three trading phases. During post and pre-trading, from 18:31 to 19:00 and from 8:30 to 9:45, only contract trades, so called after market I and II trades can be recorded. Opening call and closing call are held from 9:45 to 10:15 and 18:20 to 18:30, during which contract trades can't be reported. Continuous trading lasts from 10:00:30 to 18:20, during which both contract trades and automatic order book trades are allowed. The overlapping times between call and continuous trading are explained by sequential start² of the continuous trading. In accordance to trading hours, the data has been divided into two subsamples; outside

¹ Before the new CNS system the service was free for the listed companies.

² The order books uncross in predetermined order, based on their historical trading volume during the opening and closing call and their market capitalization. Changes in the order of uncross are allowed only during the closing call if the equilibrium price or volume changes drastically.

trading hours subsample consists of earnings announcements disclosed outside the continuous trading (from 18:30:00 to 10:00:00) ¹, during trading hours subsample consists of announcements disclosed during the continuous trading (from 10:00:01 to 18:29:59). Trades conducted during after market I and II are excluded from this study. The reason for this is that majority of these trades relate to different settlement cycle, other settlement related reasons, their price does not represent prevailing market price or in case of after market II trades belong to previous trading day. However, contract trades conducted during the continuous trading are included, since they generally are conducted at the prevailing market price.

The data of 338 announcements consists of 91 annual earnings announcements and 247 quarterly earnings announcements. All of the 91 annual earnings announcements included also the quarterly earnings announcements from the last quarter. Table 1 presents the distribution of earnings announcements into the outside trading hours- and during trading hour's subsamples. Results not provided in this paper, reveal no common factor for either of the subsamples, and that both subsamples consists of large and small, liquid and less liquid companies.

As table 1 shows, the sample data is fairly evenly divided between announcements disclosed outside and during trading hours. Generally, companies tend to have fairly fixed reporting schedule. Out of the 32 companies selected in this sample, 21 companies (66%) reported their earnings always during the same period, 4 had once tried a different reporting period and only 7 had changed their reporting schedules more than once. This is in contradiction to Pronk (2006) who in his study of 336 NYSE and AMEX listed companies finds that 55% of the companies did not have fixed strategy of announcing the earnings consistently during trading or during non-trading hours.

¹ Only one of the announcements was disclosed at the evening, while 12 announcements were disclosed during the morning auction. Due to the small amount of during the auction earnings announcements, no separate group was created for them.

Table 1.

The Distribution of Earnings Announcements

This table shows the 338 quarterly or annual earnings announcements accepted in the ultimate sample as well as their allocation into two subsamples (outside- and during trading hours). Second column presents the required times for each announcements in order to qualify for the subsample and the third column presents the amount of announcements within each subsample.

Subsample	Time of the disclosure	Number of Disclosures
Outside trading hours ¹	18:30:00 – 10:00:00	163
During trading hours	10:00:01 – 18:29:59	175

The trading data used in this study consists of all trades, orders, order amendments and other changes made in the trading system during the research interval. The use of this conclusive data set would have not been possible without the permission of Helsinki Stock Exchange. The data is retrieved from Computershare's Securities Markets Automated Research Trading and Surveillance (SMARTS) system. SMARTS-system is used by Helsinki Stock Exchange for trading surveillance purposes. Needless to say that it has been my honor and privilege to use this unique data.

¹ In the auction shares uncross in a predetermined order, starting from the most liquid ones. Since OMXH25 shares are the most liquid 25 shares in the Helsinki Stock Exchange they will always uncross first. Careful attention has been paid that no announcement released after the uncross is classified as off-hours announcement

5. Methodology

This Chapter discusses the methodology used to investigate the hypothesis stated in Chapter 3. The Chapter is divided into two parts, subchapter 5.1 presents the variables used in univariate analysis while subchapter 5.2 presents the regression model and its underlying assumptions. Subchapter 4.1 is further divided into two parts; first part presents variables, which are comparable to previous research, while some additional variables are presented in the second part.

5.1. *Variables Used*

I have followed Pronk (2006) and Libby, Mathieu and Robb (2002) and identified the variables presented in Chapter 5.1.1. In order to capture further information about the earnings announcements effects to the order book some additional variables presented in the Chapter 5.1.2 are used.

In accordance to Lee, Mucklow and Ready (1993), Krinsky and Lee (1996) and Pronk (2006) I have divided each trading day into seventeen¹ half-hour trading intervals. Period [0] is defined as the period including the earnings announcement. Announcement period is defined as +/- 34 half-hour periods around disclosure of the announcement. This potentially extends the announcement period into third trading day (announcements made during continuous trading) or covers two trading days around the earnings announcement (overnight announcements). The non- announcement period is defined as 30 trading days before the announcement period. Thus, days -32 through -3 before the earnings announcement typically form the non-announcement period.

In order to take into account the fact that trading volumes and thus presumably order book composition varies across the trading day each observation during the half-hour period is adjusted against its non-announcement median values. Thus all variables are

¹ Prior studies have used 13 half-hour intervals due to differences in trading calendar. Continuous trading in Helsinki Stock Exchange lasts from 10:00 to 18:30, which explains the use of 17 half-hour intervals.

constructed in a way that each half-hour during the announcement period is compared against the median of the same half-hour periods during non-announcement period¹. This follows the methodology of Libby, Mathieu and Robb (2002) and Pronk (2006).

5.1.1. Comparable Variables

Bid-Ask Spread

Bid-Ask Spread is the percentage difference between time-weighted bid-ask spread during +/-34 half-hour periods around the earnings announcement and median time-weighted spread during non-announcement period. Based on the prior literature, higher uncertainty is expected to increase bid-ask spread, while new information is expected to narrow the bid-ask spread. Variable *SPREAD* is defined as:

$$SPREAD_h = \frac{\left(\frac{AP_h - BP_h}{MP_h}\right)}{\text{Median}\left(\frac{AP_{hi} - BP_{hi}}{MP_{hi}}\right)} - 1, \quad i = -3, -4, \dots, -32 \quad (1),$$

where AP_h is the time-weighted ask price during half-hour interval (h) and BP_h is the time-weighted bid price during the same half our interval and MP_h is the time-weighted midpoint price² during the same half-hour interval. Respectively, AP_{hi} , BP_{hi} and MP_{hi} are time-weighted median figures during respective half our interval of the non-announcement period (i). The negative value for variable *SPREAD* implies that relative spread during announcement period is smaller than during non-announcement period and vice versa.

¹ For instance if the earnings announcement is made at 11.00:00, observation $O_{11.00-11.30}$ is compared to median value of non announcement period observations $N_{-3}11.00-11.30, \dots, N_{-32}11.00-11.30$.

² Bid/ask midpoint price

Depth at the Best Level (Quoted Depth)

Depth at the best level¹ is the percentage difference between time-weighted depth at the best bid and ask levels during +/-34 half-hour periods around the announcement moment and median time-weighted depth at the best bid and ask level during non-announcement period. Depth at the best level is expected to be smaller at the times of higher uncertainty and larger after the release of new information. Variable *BDEPTH* is defined as:

$$BDEPTH_h = \frac{BAD_h + BBD_h}{Median(BAD_{hi} + BBD_{hi})} - 1, i = -3, -4, \dots, -32 \quad (2),$$

where BAD_h is the time-weighted ask side depth (at the best level) during half our interval (h) and BBD_h is the time-weighted bid side depth (at best level) during the same half our interval. Respectively, BAD_{hi} and BBD_{hi} are time-weighted median ask and bid side depths during respective half our interval of the non-announcement period (i). The negative value of the variable *BDEPTH* implies that relative depth during announcement period is smaller than during non-announcement period and vice versa.

Trading Volume

Trading volume is the percentage difference between number of shares traded during the half-hour announcement period and median number of shares traded in the non-announcement period. According to Kim and Verrecchia (1994) trading volume may raise even though information asymmetry increases as informed traders try to take advantage of their private information. Variable *VOLUME* is defined as:

$$VOLUME_h = \frac{V_h}{Median(V_{hi})} - 1, i = -3, -4, \dots, -32 \quad (3),$$

where V_h is the total number of shares traded during the half our interval (h), which is divided by V_{hi} , median number of shares traded during comparable half-hour period of the non-announcement period (hi). The negative result from the formula implies that the

¹ Throughout this paper this variable is occasionally referred as quoted or relative depth, due to the fact that prior research investigating specialists have not used any other variables describing the order book depth.

volume during the announcement period is smaller than during the non-announcement period and vice versa.

5.1.2. Other Variables

Since the scope of this research is to investigate market wide reactions to earnings announcements, as opposed to prior studies which have concentrated on specialists' actions, I have also investigated some additional variables provided by SMARTS-system. The reason that these variables are included is that they are likely to provide more comprehensive view of the market participants' reactions to earnings announcements. Although some of them are direct derivatives of the previously presented variables, I believe that they nevertheless provide additional information of order book composition.

Total Order Book Depth

Total order book depth is the percentage difference between time-weighted total order book depth during +/-34 half-hour periods around the announcement and median time-weighted total order book depth during the non-announcement period¹. The total order book depth is expected behave similarly, but less drastically as variable BDepth. It is included in order to document the response of the total order book to earnings announcement. Variable *TDEPTH* is defined as:

$$TDEPTH_h = \frac{TAD_h + TBD_h}{Median(TAD_{hi} + TBD_{hi})} - 1, i = -3, -4, \dots, -32 \quad (4),$$

where TAD_h is the total time-weighted ask side depth during the half our interval (h) and TBD_h is the total time-weighted bid side depth the same half our interval. Respectively, TAD_{hi} and TBD_{hi} are time-weighted median figures during respective half our interval of the non-announcement period (i). The negative value of the variable implies that the total

¹ Total Depth as well as other order book depth variables takes into account all orders in the order book. Thus, publicly non-visible and rarely available information about hidden orders is also taken into account.

depth during announcement period is smaller than during non-announcement period and vice versa.

SMARTS Liquidity Formula

SMARTS liquidity formula measures the liquidity 5 percentages around the midpoint price, by giving weight 0 to orders that are 5 percentages away from the midpoint price, while midpoint price itself is weighted by 1 and in-between is a linear interpolation. Since the price of the security rarely changes more than 5 percentages from its pre-announcement value it is reasonable to believe that this variable should capture most of the orders intended to be executed during the announcement day. Although this variable is measured in monetary terms, it is expected to behave as variables BDepth and TDepth. Variable *LIQUID* is defined as:

$$LIQUID_h = \frac{\sum_{i=1}^n O_{hi} * \sum_{j=0}^1 w_{hj}}{Median(\sum_{i=1}^n O_{hik} * \sum_{j=0}^1 w_{hjk})} - 1, k = -3, -4, \dots, -32 \quad (5),$$

Variable *LIQUID* takes into account the monetary value of orders (o) within 5 percentages of the midpoint price and weight them by giving weight (w) 0 to orders that are 5% away from the midpoint price, while midpoint price itself it's weighted by 1 and in-between is a linear interpolation. Percentage comparison between announcement period, half our interval (h) and respective half our interval of the non-announcement period (k) is used in order to provide comparable results.

Volume Weighted Spread

Volume weighted spread measures the spread by calculating all orders in the order book and weighting them by their respective quantities¹. The volume weighted spread is the percentage difference between volume weighted spread during +/-34 half-hour periods around the announcement moment and median volume weighted spread during non-announcement period. Volume weighted spread is included in this study, because it

¹ For Nokia Corporation, the most liquid share traded in Helsinki Stock Exchange, volume weighted spread typically varied around 6%, while the bid-ask spread is typically around 0.04% to 0.05% (0.01€).

provides picture on what price could an investor buy the full offering of either side of the order book¹. Since it is rarely the case that nobody could perform such operation in the modern markets, volume weighted spread provides stable variable to measure the effect caused by earnings announcement. Variable *VWSPREAD* is defined as:

$$VWSPREAD_h = \frac{\left(\frac{VWAP_h - VWBP_h}{MP_h} \right)}{\text{Median}\left(\frac{VWAP_{hi} - VWBP_{hi}}{MP_{hi}} \right)} - 1, i = -3, -4, \dots, -32 \quad (6),$$

where, $VWAP_h$ is the volume weighted ask price during half our interval of the earnings announcement period (h) and $VWBP_h$ is the volume weighted bid price during the same half our interval and MP_h is the time-weighted midpoint price during the same half our interval. Respectively, $VWAP_{hi}$, $VWBP_{hi}$ and MP_{hi} are median figures of the respective half our interval during the non-announcement period (i). The negative result from the formula implies that volume weighted spread during announcement is smaller than during non-announcement period and vice versa.

Trade Initiated by Buyer or Seller

The “trade initiated by buyer or seller”- variable measures the relation between trades initiated by buyer (bid) and seller (ask). It provides information whether on the buy or the sell side investors are more active around the earnings announcement. In a normal case, if the market is functioning properly, equal amount of buyer and seller initiated trades are expected to occur. However, increased amount of buyer or seller initiated trades before the earnings announcements can be seen to mean one of the two things: either somebody is taking advantage of private information before the earnings announcement (information asymmetry) or that market participants are creating parallel positions before the announcement. Variable *INITIMB* is defined as:

¹ Please note that Helsinki Stock Exchange uses price limits of +/- 15 percentage from the yesterdays close, the reference price. This may cause some errors in variables, particularly in relation to this variable, since some of the orders that would have otherwise been inserted are not technically allowed by the exchange, because of the breach of +/- 15 % price limit rule. Trading Surveillance Finland may alter these limits intraday, if it deems the price movement justifiable.

$$INITIMB_h = \frac{\frac{N(Bih)}{N(Bih) + N(Sih)}}{\text{Median}\left(\frac{N(Bihi)}{N(Bihi) + N(Sihi)}\right)} - 1, i = -3, -4, \dots, -32 \quad (7),$$

In its base form the formula is calculated as: number of buyer initiated trades $N(Bi)$ divided by sum of the number of buyer initiated trades $N(Bi)$ and number of seller initiated trades $N(Si)$ during the selected interval. This formula should yield answer 100 if all trades would be buyer initiated and 0 if all trades where seller initiated. In order to analyse the variable, observations ± 34 half-hour periods (h) around the announcement moment are divided by median figures of the respective half our interval during the non-announcement period (i).

Intraday Volatility

Intraday volatility is measured in order to verify whether earnings announcements during continuous trading increase uncertainty in the order book in a form of increased price deviation compared to announcements made outside trading hours. As an exception of usual way to calculate volatility, I have calculated variable *VOLA* as a continuous (time-weighted) standard deviation of midpoint price and compared it against it's non-announcement period median:

$$VOLA_h = \frac{\sqrt{\frac{\sum_{i=1}^n (x_{hi}^2 - \bar{x}_h^2)}{n-1}}}{\sqrt{\frac{\sum_{i=1}^n (x_{hji}^2 - \bar{x}_{hj}^2)}{n_j-1}}} - 1, j = -3, -4, \dots, -32 \quad (8).$$

where x_i is the midpoint price at time i ($i=1,2,\dots,n$) and \bar{x} is the average midpoint price¹ during half our interval of the earnings announcement period (h). Median figures of the respective half our interval during the non-announcement period (i) are used in order to compare the changes in the intraday volatility.

¹ I have used midpoint price in order to ignore bid-ask bounce, but according to developers of SMARTS-system it can be more erratic when applied to very illiquid securities. OMXH25 shares are selected in order to avoid this problem

Average Trade Value

Average trade value is the percentage difference between the average trade value during the half-hour announcement period and median volume during non-announcement period. Variable average trade value is calculated in order to identify times when investors' increased confidence makes them to trade in larger quantities. Variable ATV is defined as:

$$ATV_h = \frac{ATV_h}{Median(ATV_{hi})} - 1, i = -3, -4, \dots, -32 \quad (9),$$

where ATV_h is the average trade value during the half our interval (h), which is divided by ATV_{hi} , median average traded value of the comparable half-hour periods during non-announcement period (hi). The negative result from the formula implies that the average trade value during the announcement period is smaller than during the non-announcement period and vice versa.

5.2. Regression Model

Lee, Mucklow and Ready (1993) argued that specialists manage both quoted depth and quoted spread simultaneously, in order to protect themselves against the risk of dealing with informed traders. Kavajecz (1998) and Dupont (2000) demonstrate that specialist may use spreads and depths as substitutes in dealing with information risk. In this study I have followed Libby, Mathieu and Robb (2002) in order to confirm whether the markets participants adjust to increase in the level of information asymmetry by widening spreads and decreasing depths simultaneously. The regression model described below is an adaptation of Libby, Mathieu and Robb (2002) regression model.

In order to capture the simultaneity of the market participants reaction I use a simultaneous two-stage least squares model. For comparison I also report the results from the ordinary least squares model (OLS). The following regression models are used:

$$\text{DEPTH}_i = \alpha_0 + \alpha_1 \text{RSPREAD} + \alpha_2 \text{BEF/AFTER} + \alpha_3 \text{ANNUAL} + \alpha_4 \text{TRADINGH} + \alpha_5 \text{RVOLUME} + \alpha_6 \text{ANNUAL_BEF} + \alpha_7 \text{VOLA} + \epsilon_i \quad (10)$$

$$\text{SPREAD}_i = \beta_0 + \beta_1 \text{RDEPTH} + \beta_2 \text{BEF/AFTER} + \beta_3 \text{ANNUAL} + \beta_4 \text{TRADINGH} + \beta_5 \text{VARVOL} + \beta_6 \text{ANNUAL_BEF} + \beta_7 \text{VOLA} + \epsilon_i \quad (11)$$

Where,

DEPTH_i	=	relative depth in the event period of observation i;
SPREAD_i	=	relative spread in the event period of observation i;
BEF/AETER	=	a dummy variable equal to 1 for the period after the announcement and 0 otherwise;
$\text{ANNUAL} =$		a dummy variable equal to 1 when the announcement is an annual earnings announcement and 0 otherwise;
$\text{TRADINGH} =$		a dummy variable equal to 1 when the announcement is made outside trading hours and 0 otherwise;
$\text{RVOLUME}_i =$		relative volume (in percentage) during the event period of observation i;
$\text{VARVOL} =$		the variance of the relative volume during the event period
$\text{ANNUAL_BEF} =$		a multiplicative dummy variable for the variable ANNUAL and BEF/AFTER equal to 1 for the period after an annual announcement and 0 for the period before quarterly announcements, the period before annual announcements, and the period after quarterly announcements.
$\text{VOLA} =$		intraday volatility in the event period of observation i;

One of the modifications made to Libby, Mathieu and Robb (2002) regression model is the discharging of a dummy variable indicating cross-listing in other markets. Libby, Mathieu and Robb (2002) used cross-listing dummy in order to control for the presence of additional information required by the U.S. Securities and Exchange Commission (SEC) as compared to the requirements of the Ontario Securities Commission. Pronk (2006) supported the use of cross-listing dummy by arguing that, if a company is cross-listed in other exchange where the trading begins prior to the exchange subject to research, the price information acquired is likely to decrease the level of information asymmetry. Finnish companies have cross-listings only in OMX Nordic Exchange Stockholm (6 cross listings) where the trading hours and rules, disclosure requirements and legislation

are identical to Helsinki Stock Exchange and in NYSE (3 cross listing) which starts trading six and half-hours later, but where disclosure requirements are tighter. Despite the strong arguments made by Libby, Mathieu and Robb (2002) and Pronk (2006) the cross listing dummy is excluded from this study due to the small amount of cross-listings in the NYSE, where the legislative environment is different and because all the Finnish companies subject to this study had disclosed their earnings announcements in a manner that no official trading is possible before the trading in Helsinki Stock Exchange begins.¹

Another modification to the model is adding the intraday price volatility (VOLA) in the regression model. Intraday volatility is measured as a continuous (time-weighted) standard deviation of the midpoint price during each half-hour period before and after the earnings announcement². Although not included in Libby, Mathieu and Robb (2002) model, I consider volatility in price is an important controlling factor for spread and depth since increased deviations in share prices is likely to affect both of them. Tests, not reported in this paper, show that adding the VOLA in to the model increase the explanatory power of the model.

The third modification to Libby, Mathieu and Robb (2002) model is the exclusion of two variables; relative mean spread in (11) and relative mean depth in (10). Both of them measure the relative spread and depth, respectively, of the all other firms in the given market. Libby, Mathieu and Robb (2002) argue that these variables control for other factors, which may affect the observed relative depth and spread for a given firm. The reasons for excluding these two variables were the results not presented in this paper, which indicated unreasonably high coefficient for relative mean spread in (11) and the fact that the exclusion of the two variables did not decrease the explanatory power of the model.

¹ The results from studies investigating cross-listings are mixed. Libby, Mathieu and Robb (2002) found that gross-listing had positive and statistically significant effect on specialist's quoted depth (at the 5% level) and negative and statistically significant effect on specialist's quoted spread (at 10% level). On the other hand Pronk (2006) found that gross listing had positive and significant effect on specialist's quoted spread (at 10% level), but negative and insignificant effect on specialist quoted depth.

² Please refer to Chapter 5.1 for more details of the intraday volatility

Table 2 below presents the expected signs for each variable's coefficient in the regression model. The rest of this chapter explains the reasoning and underlying assumptions of these expectations.

Table 2. Expected signs

This table presents the expected signs for each variable in the regression model. Each variable is listed on the first column, while expected signs of their coefficient in (10) and (11) are presented in columns two and three, respectively.

	Expected Sign	
	Relative Depth (10)	Relative Spread (11)
Intercept	?	?
RSPREAD	-	n/a
RDEPTH	n/a	-
BEF_AFTER	+	-
ANNUAL	?	?
TRADINGH	-	+
VARVOL	n/a	-
RVOLUME	+	n/a
ANNUAL_BEF	?	?
VOLA	-	+

Given the inverse relationship between depth and spread, higher order book depth is related with lower spread and vice versa, I expect a negative sign on *RSPREAD* in (10) and negative sign on *RDEPTH* in (11). The expected signs for the OLS model are the same as those predicted for (11). Furthermore, Hypothesis I predicted that quoted spreads would be wider and quoted depths lower just before the earnings announcements than in the non announcement period. Based on Hypothesis I, I expect to find positive sign on *BEF/AFTER* in (10) and negative sign on *BEF/AFTER* in (11).

According to the Hypothesis II there would be no difference between relative spreads and relative depths before the announcement of quarterly earnings news and before the announcement of annual earnings news. Therefore I do not expect to find statistically significant signs for variable *ANNUAL* in either of the regression equations. This is in contradiction to Libby, Mathieu and Robb (2002) who assumed higher level of

information asymmetry before the disclosure of quarterly earnings (relative to annual earnings) and therefore predicted a positive sign on *ANNUAL* in (10) and a negative sign in (11).

For variable *TRADINGH* I expect to find negative sign in (10) and positive sign in (11). That is, I expect greater uncertainty if the earnings announcement is made outside trading hours and thus I expect to find that relative spreads will remain wider and relative depths will remain lower for a longer period of time. These predictions are in line with Hypothesis III and Libby, Mathieu and Robb (2002) findings, but do contradict the findings of Pronk (2006) and some of the arguments presented in Chapter 3.7.

I am also controlling the changes in spreads and depths by using two instrumental variables *VARVOL*, volatility in volume and *RVOLUME*, relative volume. Libby, Mathieu and Robb (2002) argue that the use of these two instrumental variables is justified, because volume available for each trade (that is, depth) is linked to relative volume while the variance in relative volume, capturing the notion of risk, is associated with posted price. I expect to see a positive sign on *RVOLUME* in (10) based on Lee, Mucklow and Ready (1993) suggestion that negative correlation between spread and depth allows for a logical prediction of the relationship between depth and volume. That is, if spread and volume are negatively related and spread and depth are negatively related, then depth and volume should be positively related. Likewise, I expect the high volatility in volume to increase the adverse selection risk faced by market participants and thus expect a negative sign on *VARVOL* in (11). Moreover, increased uncertainty among market participants is expected to reduce their willingness to offer shares to the order book and thus increase the volatility. This is likely to increase order book spread and decrease order book depth. Consequently, I predict to find negative sign for *VOLA* in (10) and positive sign for *VOLA* in (11).

Variable *ANNUAL_BEF*, is a multiplicative dummy variable that captures the interaction between the variables *ANNUAL* and *BEF/AFTER*. Following Libby, Mathieu and Robb (2002) I do not predict a sign for *ANNUAL_BEF*. According to Libby,

Mathieu and Robb (2002) a positive sign would be consistent with relative depth that is lower before quarterly and annual announcements than it is after the announcement of annual earnings. However, a negative sign is possible if relative depth after a quarterly announcement is positive and significantly higher than it is after an annual announcement. The same applies to the relative spread.

6. Univariate Analysis

This chapter presents the univariate analysis of the selected variables during the earnings announcements. Variables are divided into three groups; the first group consists of descriptive variables; trading volume, intraday volatility, average trade value and trade initiated by buyer or seller. The second group consist of variables describing the bid-ask spread, consisting of spread and volume weighted spread. Finally, in the third group earnings announcement effects to the order book depth are analyzed using the following variables: quoted depth, total order book depth and liquidity 5% around the midpoint price. A short summary of differences between annual vs. quarterly and during vs. outside trading hour's earnings announcements is provided at the end.

6.1. *Descriptive Variables*

6.1.1. Volume

Table 3 presents variable *VOLUME* results during the period of +/-34 half-hour intervals (+/-2 trading days) around the earnings announcements. Half-hour intervals are combined into 15 parts. Table is further divided into three parts; full sample, during trading hours and outside trading hours earnings announcements. The sign-test is used in order to determine whether or not observations differ statistically from zero and Wilcoxon rank-sum test when comparing whether two subsamples differ from each other's.

Not surprisingly, the full sample trading volume is positive and statistically significant throughout the observation period. Full sample trading volume increases modestly towards the disclosure of the earnings announcement peaking during the period [0], right after the release of earnings announcement. Increased, albeit declining trading volumes, are observed throughout the rest of the earnings announcement day. The trading volumes on the second day after the disclosure are also positive and statistically significant, although significantly smaller than immediately after the disclosure of the earnings announcement. The observed increase in the trading volume is in line with Kim and

Verrecchia (1994) suggestion that investors capable of informed judgments would increase trading around earnings announcements.

Table 3.
Trading Volume

This table presents the changes in trading volume (*VOLUME*) during the period of +/- 34 half-hour intervals (+/- two trading days) around the earnings announcements. Volume is calculated as number of shares traded over the given time interval divided by the non-announcement period median value. The announcement period is divided into 15 parts presented in the first row. Table is further divided into three parts. First part, rows three to six, present the full sample divided into annual and quarterly earnings announcements. Second part, rows seven to ten present the results from earnings announcements made during trading hours. In the third part, rows eleven to fourteen, results from the outside trading hours earnings announcements are presented. Last row presents the statistical difference between during and outside trading hours earnings announcements. Sign-test and Wilcoxon rank-sum test are used when applicable. Following signs for statistical significance are used:

*** Significantly different from 0 at 1% level

** Significantly different from 0 at 5% level

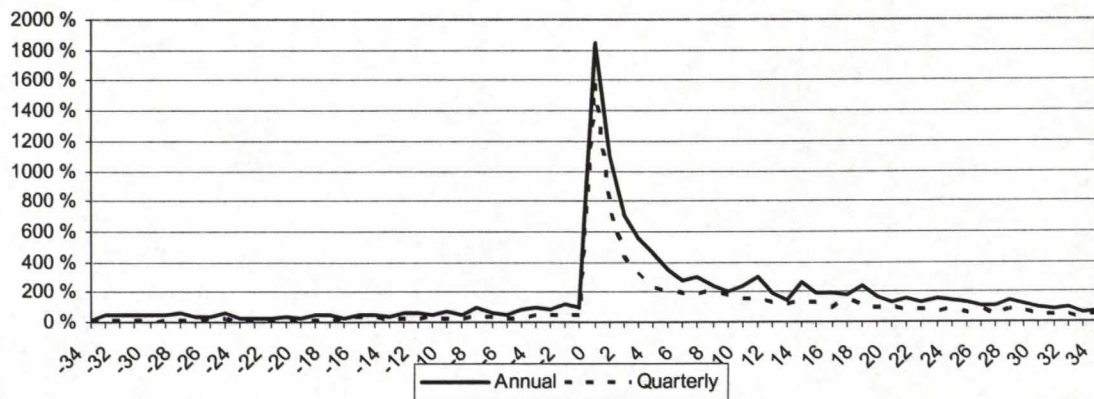
‡ Significant at 1% level

† Significant at 5% level

	Median Values														
	[-34 -31]	[-30 -26]	[-25 -21]	[-20 -16]	[-15 -11]	[-10 -6]	[-5 -1]	[0]	[1 5]	[6 10]	[11 15]	[16 20]	[21 25]	[26 30]	[31 34]
Full Sample	0,17***	0,21***	0,15***	0,21***	0,33***	0,38***	0,57***	16,96***	4,26***	2,00***	1,50***	1,29***	0,93***	0,80***	0,53***
Annual	0,36***	0,47***	0,35***	0,48***	0,49***	0,66***	0,94***	18,49***	5,81***	2,48***	2,28***	1,83***	1,43***	1,15***	0,77***
Quarterly	0,11***	0,13***	0,08**	0,15***	0,28***	0,30***	0,45***	15,86***	3,65***	1,83***	1,37***	1,13***	0,79***	0,66***	0,43***
Annual vs. Quarterly	‡	‡	‡	‡	‡	‡	‡		‡	‡	‡	‡	‡	‡	‡
During Trading Hours	0,22***	0,24***	0,15***	0,27***	0,36***	0,39***	0,65***	17,96***	3,62***	1,82***	1,26***	1,03***	0,70***	0,57***	0,30***
Annual	0,51***	0,51***	0,37***	0,53***	0,62***	0,62***	1,04***	28,01***	7,09***	2,63***	1,92***	1,31***	1,20***	0,95***	0,50***
Quarterly	0,14***	0,11***	0,04	0,20***	0,31***	0,33***	0,45***	14,85***	2,81***	1,45***	0,96***	0,94***	0,53***	0,42***	0,20***
Annual vs. Quarterly	‡	‡	‡	‡	‡	‡	‡	‡	‡	‡	‡	‡	‡	‡	†
Outside Trading Hours	0,13***	0,20***	0,15***	0,17***	0,29***	0,37***	0,52***	15,86***	4,76***	2,25***	1,81***	1,54***	1,21***	1,05***	0,72***
Annual	0,26***	0,40***	0,30***	0,39***	0,41***	0,71***	0,82***	14,24***	5,47***	2,40***	2,57***	2,39***	1,66***	1,52***	1,17***
Quarterly	0,10**	0,13***	0,11**	0,11***	0,24***	0,26***	0,45***	16,25***	4,56***	2,17***	1,73***	1,28***	1,00***	0,94***	0,57***
Annual vs. Quarterly	†	‡	‡	‡		‡	‡					‡	‡	‡	‡
During vs. Off hours									‡	‡	‡	‡	‡	‡	‡

Trading volumes around annual (solid line) and quarterly (dash line) earnings announcements are presented in Figure 1. Regardless of the announcement type (annual or quarterly), trading volumes around the earnings announcements are higher than during non-announcement period. Figure 1 reveals that the increase in trading volume seems to be higher if the earnings announcement is of annual type. Table 3 confirms that the difference in trading volumes between annual and quarterly earnings announcements is statistically significant (at 1 percentage level) in favor of annual earnings announcements during all periods except one, period [0].

Figure 1.
Trading Volume Around Annual and Quarterly Earnings Announcements



Although the results indicate that annual earnings announcements attract higher interest among investors than quarterly earnings announcements, results do not reveal that investors would see the information content of annual earnings announcements more reliable than the information content in quarterly earnings announcements. It is probable that increased trading volumes around annual earnings announcements is caused by additional information provided by annual earnings announcements. Such information may include things like dividend proposals, proposal to buy back shares or proposal for the new Board Members, both of which are commonly disclosed in the annual earnings announcements of the Finnish companies.

Table 1 also provides information about differences in trading volumes between earnings announcements disclosed during and outside trading hours. Trading volume in both of these subsamples is positive and statistically significant throughout the observation period. Statistically significant evidence that trading volumes after earnings announcement disclosed outside trading hours is larger is discovered during periods [1, 34]. This provides clear evidence that companies who decide to disclose their results outside trading hours can expect their share to experience higher trading volumes than if they would choose to disclose the announcement during continuous trading.

My results support the findings of Libby, Mathieu and Robb (2002) and Pronk (2006), both of whom report significant increases in specialists' trading volume after the earnings

announcement. However, my results indicate significantly larger increase in trading volumes than previously documented¹. This is probably due to the fact that I have monitored overall market reaction, while previous studies have concentrated on specialists' actions. Moreover, my results indicating that total trading volume between annual and quarterly earnings announcements differ, is something which Libby, Mathieu and Robb (2002) do not support.

6.1.2. Volatility

Results from the variable *VOLA* are presented in Table 4. Half-hour intervals are combined into 15 parts. Table is further divided into three parts; full sample, during trading hours- and outside trading hours earnings announcements. Sign-test is used in order to determine whether or not observations differ statistically from zero and Wilcoxon rank-sum test when comparing whether two subsamples differ from each other.

Table 4 shows that full sample volatility is statistically different from zero throughout the observation period and peaks during period [0]. Like variable *VOLUME*, volatility increases significantly after the disclosure of the earnings announcement and declines slowly towards its non-announcement period median. Statistical significance, in favor of annual earnings announcements, is observed during periods [-5, -1] and [1, 10]. Interestingly, this difference is driven by during trading hours subsample, as no statistical difference between annual and quarterly earnings announcements is observed if the earnings announcement is disclosed outside trading hours. This phenomenon is similar to the behavior of variable *VOLUME*, which also tends to be larger after annual earnings announcements disclosed during trading hours.

¹ Libby, Mathieu and Robb (2002) document that specialist trading volume increases 23 percentages and Pronk (2006) 59.9 percentages in his overnight sample, after the disclosure of earnings announcement.

Table 4.
Intraday Volatility

This table presents the changes in intraday volatility (*VOLA*) during the period of +/- 34 half-hour intervals (+/- two trading days) around the earnings announcements. Volatility is calculated as volatility over each interval measured as continuous (time-weighted) standard deviation of midpoint price and compared to non-announcement period mean value. The announcement period is divided into 15 parts presented in the first row. Table is divided into three parts. First part, rows three to six, present the full sample divided into annual and quarterly earnings announcements. Second part, rows seven to ten present the results from earnings announcements made during trading hours. In the third part, rows eleven to fourteen, results from the outside trading hours earnings announcements are presented. Last row presents the statistical difference between during and outside trading hours earnings announcements. Sign-test and Wilcoxon rank-sum test are used when applicable. Following signs for statistical significance are used:

*** Significantly different from 0 at 1% level

** Significantly different from 0 at 5% level

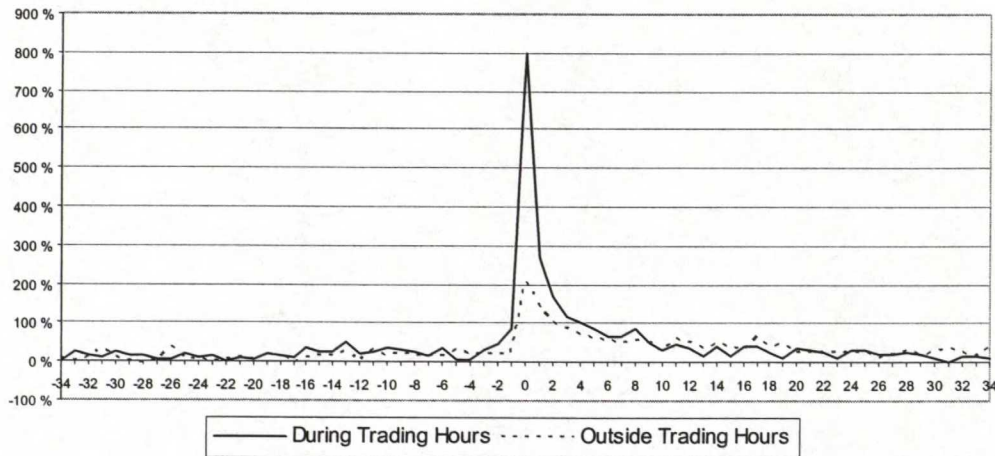
‡ Significant at 1% level

† Significant at 5% level

	Median Values														
	[-34 -31]	[-30 -26]	[-25 -21]	[-20 -16]	[-15 -11]	[-10 -6]	[-5 -1]	[0]	[1 5]	[6 10]	[11 15]	[16 20]	[21 25]	[26 30]	[31 34]
Full Sample	0,13***	0,11***	0,08***	0,10***	0,21***	0,21***	0,27***	3,69***	1,09***	0,54***	0,38***	0,36***	0,26***	0,21***	0,23***
Annual	0,06	0,14**	0,09***	0,12***	0,22***	0,21***	0,36***	4,43***	1,49***	0,66***	0,51***	0,37***	0,34***	0,21***	0,22***
Quarterly	0,14***	0,11***	0,07***	0,10***	0,21***	0,21***	0,25***	3,46***	0,94***	0,50***	0,33**	0,35***	0,22***	0,21***	0,23***
Annual vs. Quarterly							‡		‡	†			‡		
During Trading Hours	0,14***	0,15***	0,10***	0,12***	0,25***	0,29***	0,38***	8,00***	1,37***	0,57***	0,28***	0,32***	0,23***	0,18***	0,14***
Annual	0,00	0,14	0,08	0,11***	0,24***	0,28***	0,55***	8,55***	1,97***	0,84***	0,48***	0,21***	0,34***	0,28***	0,13
Quarterly	0,18***	0,15***	0,12***	0,15***	0,28***	0,29***	0,30***	7,92***	1,18***	0,51***	0,21***	0,36***	0,17***	0,16***	0,14**
Annual vs. Quarterly	†						‡		‡	‡	†		†		
Outside Trading Hours	0,12***	0,09**	0,06**	0,08***	0,20***	0,19***	0,23***	2,08***	0,89***	0,51***	0,46***	0,39***	0,28***	0,23***	0,30***
Annual	0,16**	0,14	0,09**	0,13	0,21**	0,20***	0,25***	2,61***	1,13***	0,53***	0,55***	0,57***	0,34***	0,17***	0,45***
Quarterly	0,10***	0,07	0,04	0,06**	0,17***	0,18***	0,22***	1,81***	0,85***	0,50***	0,43***	0,35***	0,26***	0,26***	0,28***
Annual vs. Quarterly															
During vs. Off hours					‡		†	‡	‡		‡	‡			†

As the difference between annual and quarterly earnings announcements indicated, the most significant difference in intraday volatility is observed between earnings announcements disclosed during and outside trading hours. Figure 2 presents the intraday volatility of the earnings announcements disclosed during (solid line) and outside (dash line) trading hours. While median volatility after earnings announcements disclosed outside trading hours is over 200% higher than its non-announcement period median, volatility is over 800% higher than non-announcement period median, if the earnings announcement is disclosed during trading hours. Around the disclosure moment, during periods [-5, 5], subsample during trading hours is statistically significantly higher than outside trading hours subsample, which indicates higher uncertainty for those earnings announcements, which are disclosed during continuous trading.

Figure 2.
Intra-day Volatility Around Earnings Announcement Disclosed During and
Outside Trading Hours



Interestingly, changes in trading volume and intraday volatility appear to follow similar pattern compared to their non-announcement period values. Throughout the observation period, both variables are statistically significantly larger than their non-announcement values suggest. Moreover, values of both variables peak right after the disclosure of the earnings announcement after which they decline. However, while trading volumes appear to be larger after earnings announcements disclosed outside trading hours, intraday volatility tends to be higher if the earnings announcement is disclosed during the continuous trading. This suggests that the intraday volatility is not the key driver of increased trading volumes, but that investors tend to prefer less surprising announcements.

6.1.3. Average Trade Value

Variable *AVT* (average trade value) results are presented in table 5. As in the previous tables, the table is divided into three parts: full sample, during, and outside trading hours. Sign-test is used in order to determine whether or not observations differ statistically from zero and Wilcoxon rank-sum test when comparing whether two subsamples differ from each other.

Table 5.
Average Trade Value

This table presents the changes in average trade value (*AVT*) during the period of +/- 34 half-hour intervals (+/- two trading days) around the earnings announcements. Average trade value is the average monetary value during the interval divided by non-announcement period mean value. The announcement period is divided into 15 parts presented in the first row. Table is divided into three parts. First part, rows three to six, present the full sample divided into annual and quarterly earnings announcements. Second part, rows seven to ten present the results from earnings announcements made during trading hours. In the third part, rows eleven to fourteen, results from the outside trading hours earnings announcements are presented. Last row presents the statistical difference between during and outside trading hours earnings announcements. Sign-test and Wilcoxon rank-sum test are used when applicable. Following signs for statistical significance are used:

*** Significantly different from 0 at 1% level

** Significantly different from 0 at 5% level

‡ Significant at 1% level

† Significant at 5% level

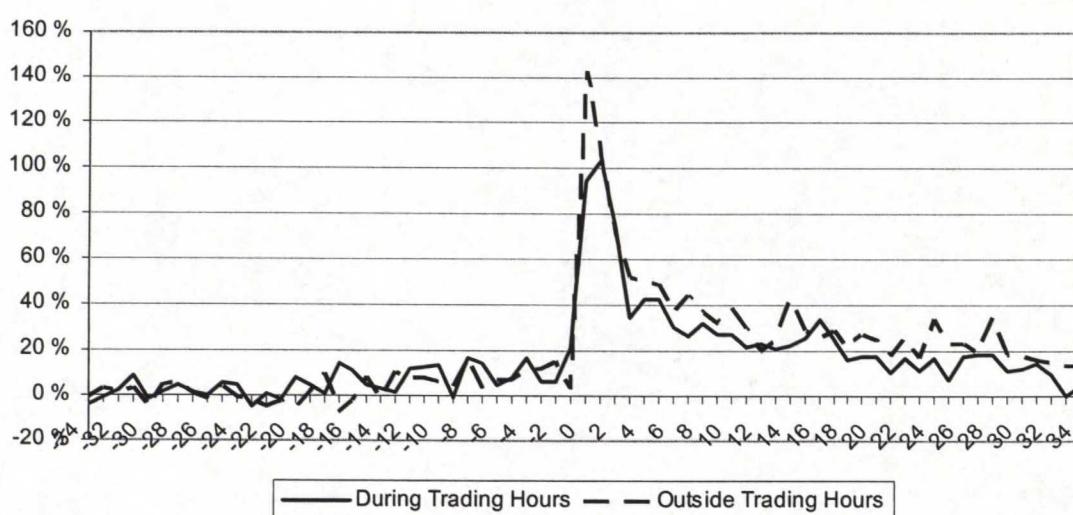
	Median Values														
	[-34 -31]	[-30 -26]	[-25 -21]	[-20 -16]	[-15 -11]	[-10 -6]	[-5 -1]	[0]	[1 5]	[6 10]	[11 15]	[16 20]	[21 25]	[26 30]	[31 34]
Full Sample	0.02	0.01**	0.00	0.03**	0.07***	0.09***	0.10***	1.16***	0.58***	0.33***	0.26***	0.24***	0.18***	0.18***	0.11***
Annual	0.12***	0.11***	0.11***	0.16***	0.15***	0.16***	0.17***	1.25***	0.68***	0.36***	0.37***	0.33***	0.30***	0.28***	0.15***
Quarterly	0.00	-0.02	-0.04***	0.00	0.05**	0.05***	0.09***	1.12***	0.56***	0.32***	0.21***	0.21***	0.13***	0.14***	0.09***
Annual vs. Quarterly	‡	‡	‡	‡	‡	‡			‡		‡	‡	‡	‡	‡
During Trading Hours	0.03	0.01	0.01	0.08***	0.07***	0.11***	0.12***	0.95***	0.56***	0.28***	0.23***	0.20***	0.12***	0.16***	0.05**
Annual	0.24***	0.15***	0.15***	0.26***	0.30***	0.18***	0.22***	1.20***	0.79***	0.37***	0.37***	0.24***	0.22***	0.18***	0.06
Quarterly	-0.04	-0.04	-0.05**	0.03	0.00	0.08***	0.09***	0.85***	0.43***	0.24***	0.16***	0.19***	0.09***	0.14***	0.05
Annual vs. Quarterly	‡	‡	‡	‡	‡	‡	‡	‡	‡	‡	‡				
Outside Trading Hours	0.02	0.01	-0.01	-0.02	0.07***	0.07***	0.09***	1.43***	0.59***	0.39***	0.28***	0.25***	0.24***	0.22***	0.14***
Annual	0.03	0.04	0.07**	0.06	0.06	0.15***	0.12**	1.25***	0.57***	0.36***	0.38***	0.45***	0.41***	0.40***	0.30***
Quarterly	0.02	0.00	-0.04**	-0.03	0.08***	0.03	0.09***	1.51***	0.60***	0.40***	0.25***	0.22***	0.17***	0.14***	0.11***
Annual vs. Quarterly			‡			‡					‡	‡	‡	‡	‡
During vs. Off hours				†				‡		‡	‡		‡	‡	‡

The full sample average trade value differs statistically from zero period [-20, -16] onwards (about one day before the earnings announcement), supporting trading volume observations. The peak observed in trading volume during the period [0] is also clearly visible in the average trade value. Moreover, as trading volume, the average trade value is positive and statistically significant, but declining after the disclosure of the earnings announcement. Although these findings highlight the fact that these two variables are closely related, they also point out that investors are willing to make larger trades (in monetary terms), not just larger amount of trades once information asymmetry is reduced, i.e. once the earnings announcement is disclosed.

The difference in average trade value between annual and quarterly earnings announcements is statistically significant throughout the period, except in period

immediately before, and after the disclosure of the earnings announcement. Table 5 reveals that this difference is driven by during trading hours subsample, during which average trade value is significantly higher if the announcement is annual earnings announcement. Figure 3 presents the difference in average trade value between earnings announcements disclosed during (solid line) and outside (dash line) trading hours. As Figure 3 shows, pre-announcement period average trade value does not differ significantly between earnings announcements disclosed during and outside trading hours, but after the disclosure of outside trading earnings announcement the average trade value is slightly higher. Table 5 reveals that the difference between during and outside trading hours subsamples is statistically significant in favor of outside trading hour subsample in six out of eight periods after the disclosure of earnings announcement.

Figure 3.
During and Outside Trading Hours Average Trade Value



If the average trade value is understood as a measure of how large bets investors are willing to make before and after the earnings announcements, the results' interpretation becomes interesting. The data of annual earnings announcement made during trading hours shows that the average trade value is significantly higher before and volatility higher after the disclosure of the announcement. This could be due to investors' expectations of higher volatility after annual earnings announcements released during trading hours, due to investors believe annual earnings announcements contain more

information than quarterly earnings announcements, or evidence of insider information. The data available is inconclusive to provide answer on this question.

6.1.4. Trade Initiated by Buyer or Seller

Table 6 presents the variable *INITIMB* (trade initiated by buyer/seller) results during the period of +/-34 half-hour intervals around the earnings announcements. The table is also divided into three parts; full sample, trading and non-trading hours. Sign-test is used in order to determine whether or not observations differ statistically from zero and Wilcoxon rank-sum test when comparing whether two subsamples differ from each other.

Table 6.
Trade Initiated by Buyer or Seller

This table presents the changes in trade initiated by buyer or seller (*INITIMB*) during the period of +/- 34 half-hour intervals around the earnings announcement. *INITIMB* is the imbalance of buyer/seller initiated trades during the interval divided by non-announcement period mean value. The announcement period is divided into 15 parts presented in the first row. Table is divided into three parts. First part, rows three to six, present the full sample divided into annual and quarterly earnings announcements. Second part, rows seven to ten present the results from earnings announcements made during trading hours. In the third part, rows eleven to fourteen, results from the outside trading hours earnings announcements are presented. Last row presents the statistical difference between during and outside trading hours earnings announcements. Sign-test and Wilcoxon rank-sum test are used when applicable. Following signs for statistical significance are used:

*** Significantly different from 0 at 1% level
 ** Significantly different from 0 at 5% level
 ‡ Significant at 1% level
 † Significant at 5% level

	Median Values														
	[-34 -31]	[-30 -26]	[-25 -21]	[-20 -16]	[-15 -11]	[-10 -6]	[-5 -1]	[0]	[1 5]	[6 10]	[11 15]	[16 20]	[21 25]	[26 30]	[31 34]
Full Sample	0.03	0.02	0.01	0.02	0.03	0.00	0.06***	0.02	0.00	0.00	0.01	0.00	0.01	0.01	0.00
Annual	0.06**	0.02	0.04	0.07***	0.09***	0.06***	0.09***	0.01	0.05***	0.02	0.02	0.06**	0.00	0.03	0.07***
Quarterly	0.01	0.02	0.00	0.00	0.01	-0.02	0.05***	0.03**	-0.01	0.00	0.01	0.00	0.02	0.00	-0.04**
Annual vs. Quarterly				†	‡	‡			‡						‡
During Trading Hours	0.00	0.00	0.03**	0.01	0.06**	0.00	0.06***	0.04	0.00	-0.03**	0.03**	0.01	0.00	-0.01	-0.02
Annual	0.03	-0.02	0.02	0.03	0.08**	0.04**	0.10***	0.01	0.04**	-0.04	0.02	0.05	-0.04	0.00	0.05
Quarterly	-0.02	0.02	0.04**	0.01	0.04	-0.03	0.05**	0.04	-0.01	-0.02**	0.04***	0.00	0.01	-0.01	-0.06**
Annual vs. Quarterly									†						†
Outside Trading Hours	0.04**	0.03	0.00	0.02	0.01	0.00	0.06***	0.01	0.00	0.04**	0.00	0.00	0.02	0.03	0.00
Annual	0.07	0.08**	0.06	0.10***	0.11**	0.12**	0.09***	-0.01	0.05	0.10***	0.02	0.07**	0.01	0.05**	0.08**
Quarterly	0.03**	0.02	-0.02	0.00	-0.02	-0.02	0.05**	0.02	-0.01	0.02	-0.02	0.00	0.03	0.02	-0.02
Annual vs. Quarterly		†	†	†	†	‡			†			†			‡
During vs. Off hours										†				†	

Table 6 indicates that in general there seems to be no difference between trades initiated by buyer or seller. Full sample results of variable *INITIMB* are positive and statistically significant only during period $[-5, -1]$. No major differences between earnings announcement disclosed during and outside trading hours can be confirmed. However, there seems to be a greater likelihood that a trade made before disclosure of annual earnings announcements would be initiated by buyer and that this difference seems to be more significant before disclosure of outside than during trading hours annual earnings announcements.

All except one of overnight sample companies reported their earnings announcements in the morning. Slightly positive values of variable *INITIMB* in the subsample of annual overnight earnings announcements indicate that trades made one day prior to these announcements are more likely to be buyer than seller initiated. Since OMXH25-index rose during the observation period a historical 74.8%, one would expect to find more positive than negative earnings announcements, thus suggesting that buying shares of these companies prior to earnings announcement and realizing the profits on announcement day could have been a profitable trading strategy.

However, the systematic leak of private information could probably be seen in very active buy side investors' participation prior to few earnings announcements, which would then drive sample median upwards. This is not however the case, a closer look to original values reveals that the amount of positive observations (buyer initiated trades) is not concentrated on few earnings announcements or few companies, but that positive observations are dispersed quite evenly¹. Moreover, in a typical case information leakage is also seen as significant increase in trading volume and increase in bid-ask spread. This is not observed in the sample to the extent that information leakage could be confirmed. An alternative explanation could be that investors are eager to speculate around earnings announcements.

¹ The sample excluded one earnings announcement where the company published its quarterly earnings announcement on its webpage one hour prior to official disclosure, which led to suspension of trading in company's share

6.2. Order Book Spread

6.2.1. Bid-Ask Spread

Table 7 presents variable *SPREAD* (bid-ask spread) results during the period of +/-34 half-hour intervals around the earnings announcements. The table is also divided into three parts; full sample, trading and non-trading hours. Sign-test is used in order to determine whether or not observations differ statistically from zero and Wilcoxon rank-sum test when comparing whether two subsamples differ from each other.

According to the full sample results in Table 7, the bid-ask spread is positive, but statistically insignificant during the post-announcement period. In particular, the negative and statistically significant values are observed during periods [1, 15] and [21, 30], are in contradiction to Kim and Verrecchia (1994) theory that increased information asymmetry would decrease the liquidity offered by market participants. However, positive and statistically significant values found during the periods [0] and [16, 20] suggest that while new information causes momentary uncertainty in the markets, this information asymmetry is solved fast by market participants¹.

The first part of the Hypothesis I predicted, in line with Libby, Mathieu and Robb (2002) findings, that in the pre-announcement period, quoted spreads would be wider than in the non-announcement period and that this effect would persist into the post-announcement period. My findings are in contradiction to both Hypotheses presented as well as to the prior evidence of specialist's actions. One of the reasons of this could be the fact that as I am investigating market wide reaction to earnings announcements, my results may be affected by the actions of non-informed investors. Alternatively, market microstructure in Helsinki Stock Exchange may encourage market participants to reduce the bid-ask spread.

¹ The full, half-hour sample, data provides evidence that spread is 0.00 during period [1] and negative and statistically significant (at 1 percent level) from thereon.

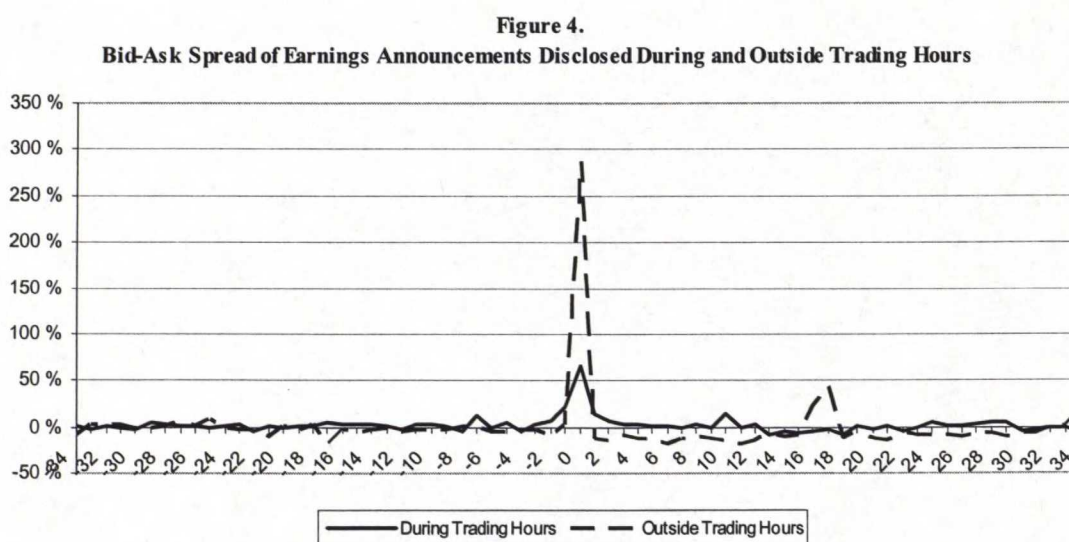
are used:

† Significant at 5% level

During vs. Off
hours

Although some evidence is provided that the spread is slightly narrower around annual than around quarterly earnings announcement, no statistically conclusive evidence is provided to support this fact. Six periods during which spread differs statistically, in favor of annual earnings announcements can be found, but since their appearance is so fragmented, Hypothesis II cannot be discarded. This result is in line with Libby, Mathieu and Robb (2002), who found no statistically significant evidence that the spread would be different between annual and quarterly announcements.

First part of the Hypothesis III predicted that relative spreads would remain wider for a longer period of time when earnings announcements occur outside trading hours than when they occur during trading hours. Figure 4, shows the bid-ask spread of earnings announcements disclosed during (solid line) and outside (dashed line) trading hours.



Despite of the fact that, during period [0] outside trading hour's earnings announcement spread is significantly larger than during trading hours earnings announcement spread, the difference between during and outside trading hours earnings announcement in the post- announcement period is evident. If the announcement is disclosed outside trading hours, spread is negative and statistically different from zero (at 1 percentage level) during periods [1, 15]. If the announcement is disclosed during trading hours the spread is

negative and statistically significant only during period [1, 5]. Moreover, Table 7 provides evidence that if the announcement is disclosed during trading hours spread is positive and statistically significant during periods [-10, -1], but negative and statistically significant during period [-5, -1], if the announcement is made outside trading hours.

This evidence of the spreads between during and outside trading announcements is in clear contradiction to Hypothesis III. Results show that if the earnings announcement is disclosed outside trading hours, bid-ask spread is significantly narrower than if the announcement occurs during trading hours. The provided evidence is also somewhat contradicting to the findings of Libby, Mathieu and Robb (2002), whose results for the full sample and outside trading hours announcements spread were positive, but insignificant during the period [1,10] and negative and significant thereafter. They also founded positive, but insignificant spread during period [-10, -1] for announcements made outside trading hours. However, the results are in line with Pronk (2006), who founded that the spread would be negative if the announcement is made outside trading hours.

6.2.2. Volume Weighted Spread

Table 8 presents the results from variable *VWSPREAD* (volume weighted spread) during the period of +/-34 half-hour intervals around the earnings announcements. This table is also divided into three parts: full sample, trading and non-trading hours. Sign-test is used in order to determine whether or not observations differ statistically from zero and Wilcoxon rank-sum test when comparing whether two subsamples differ from each other.

Table 8 shows that the full sample *VWSPREAD* is positive and differs statistically from zero during periods [-5, 15] indicating higher uncertainty around the earnings announcements. Positive and statistically significant values are also observed during periods [-34, -16], about one trading day before the disclosure of the earnings announcement. Interestingly, these findings support the Hypothesis I and are opposite to findings in *SPREAD*, which provided evidence of narrower spread after the disclosure of

earnings announcement. One probable reason, which could explain the different behavior of these two variables, is their composition. While variable *SPREAD* may consist of only few shares, variable *VWSPREAD* is less sensitive to the changes caused by a few new orders, since it accounts in all orders in the order book. Therefore *VWSPREAD* may describe the actions of larger market participants better and thus explain why it yields similar results as Libby, Mathieu and Robb (2002) found.

Table 8.
Volume Weighted Spread

This table presents the changes in Volume Weighted Spread (*VWSPREAD*) during the period of +/- 34 half-hour intervals around the earnings announcement. *VWSpread* is calculated as defined in the chapter 5.1 and the announcement period is divided into 15 parts presented in the first row. Table is divided into three parts. First part, rows three to six, present the full sample divided into annual and quarterly earnings announcements. Second part, rows seven to ten present the results from earnings announcements made during trading hours. In the third part, rows eleven to fourteen, results from the outside trading hours earnings announcements are presented. Last row presents the statistical difference between during and outside trading hours announcements. Following signs for statistical significance are used:

*** Significantly different from 0 at 1% level
 ** Significantly different from 0 at 5% level
 ‡ Significant at 1% level
 † Significant at 5% level

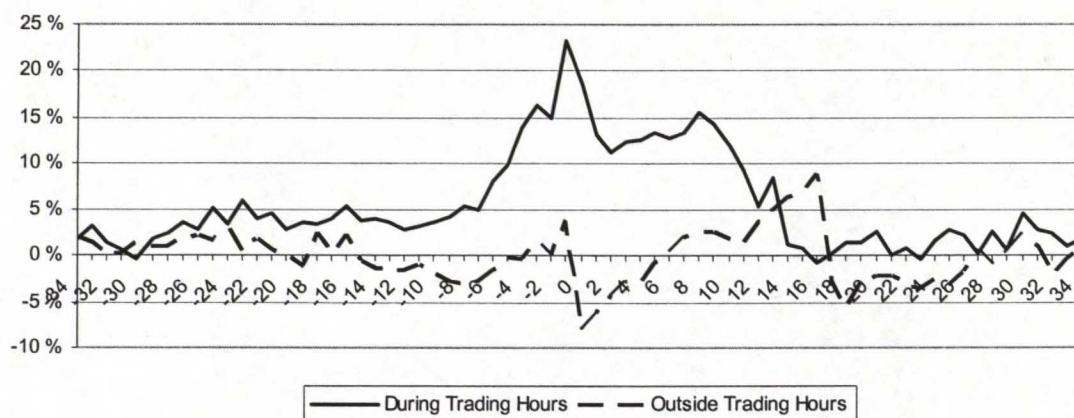
	Median Values														
	[-34 -31]	[-30 -26]	[-25 -21]	[-20 -16]	[-15 -11]	[-10 -6]	[-5 -1]	[0]	[1 5]	[6 10]	[11 15]	[16 20]	[21 25]	[26 30]	[31 34]
Full Sample	0.01**	0.02***	0.03***	0.02***	0.01	0.00	0.06***	0.04**	0.04***	0.07***	0.05***	0.00	-0.01	0.01**	0.01
Annual	-0.07***	-0.06***	-0.01	-0.02**	-0.03***	-0.01	0.06***	0.08	0.11***	0.11***	0.03***	-0.02	-0.02	0.00	0.00
Quarterly	0.04***	0.05***	0.05***	0.03***	0.02***	0.01	0.05***	0.03	0.03***	0.06***	0.05***	0.00	-0.01	0.01**	0.01
Annual vs. Quarterly	‡	‡	‡	‡	‡				‡	‡					
During Trading Hours	0.02	0.02**	0.05***	0.03***	0.03***	0.06***	0.15***	0.18***	0.13***	0.13***	0.04***	0.00	0.01	0.02**	0.02**
Annual	-0.11***	-0.08***	-0.01	-0.02	-0.01	0.02	0.12***	0.20***	0.21***	0.20***	0.02	0.00	0.01	0.03**	0.05**
Quarterly	0.06***	0.05***	0.07***	0.05***	0.05***	0.07***	0.15***	0.15***	0.10***	0.10***	0.06***	0.00	0.01	0.02**	0.01
Annual vs. Quarterly	‡	‡	‡	†	‡				‡	‡					
Outside Trading Hours	0.01	0.01	0.02	0.01	-0.01	-0.03***	0.01	-0.08***	-0.03***	0.02**	0.05***	-0.01	-0.03***	0.00	0.00
Annual	-0.04***	-0.05***	-0.02	-0.04**	-0.04***	-0.03***	0.02**	-0.10	-0.02	0.02	0.06**	-0.03	-0.05**	-0.02	-0.04
Quarterly	0.03***	0.04***	0.03***	0.02**	0.00	-0.02**	0.00	-0.08***	-0.03***	0.02**	0.05***	0.00	-0.03**	0.01	0.02
Annual vs. Quarterly	‡	‡	‡	‡	†										
During vs. Off hours			‡	‡	†	‡	‡	‡	‡	‡			‡		

If the earnings announcement is of annual type, variable *VWSPREAD* is statistically smaller during the periods [-34, -11] than if the announcement would be a quarterly earnings announcement. However immediately after the disclosure moment, during periods [1, 10], variable *VWSPREAD* is statistically larger if the earnings announcement is of annual type. A closer look reveals that this observation is driven by during trading hours announcements subsample. Unlike the results in variable *SPREAD*, these findings

are in contradiction to Hypothesis II, which predicted that there would be no difference in spreads between annual and quarterly earnings announcements.

The most significant difference in variable *VWSPREAD*, the difference between during (solid line) and outside (dashed line) trading hours earnings announcements is presented in Figure 5. Variable *VWSPREAD* is positive and statistically significant if the earnings announcement is disclosed during trading hours while if the disclosure is released outside trading hours announcements, *VWSPREAD* tends to be negative and statistically significant from zero. The difference between during and outside trading hours announcements is statistically significant during the period [-25, 10]. This phenomenon observed in Figure 5, is similar to variable *SPREAD* and provides further evidence against Hypothesis III.

Figure 5.
Volume Weighted Spread around During and Outside Trading Hours Earnings Announcements



A further analysis on volume weighted spread around outside trading hours announcement reveals that *VWSPREAD* increases steadily after the disclosure of the earnings announcement. The variable *VWSPREAD* is negative and statistically significant right after the disclosure of the earnings announcement and starts to increase until it reaches its peak at period [16], which happens to be the end of the trading day¹ for announcements disclosed outside trading hours. Since the variable is controlled by

¹ Trading day is divided into 17 half-hour periods.

dividing each observation by non-announcement period median value, a phenomenon such as this should not be caused by variable construction. Moreover, no such phenomenon is observed with any other variable, which increases the confidence that variable construction as such is not erroneous.

One alternative explanation for this phenomenon is the auction mechanism used in Helsinki Stock Exchange. According to rules of Helsinki Stock Exchange, equilibrium price during the morning auction is the price level at which the tradable volume is the largest. This may encourage investors to insert orders which are significantly better than the equilibrium price since they know that even though the price in their order may differ from the prevailing market price the worst case is that they have to make the trade at the equilibrium price. Therefore, especially after the earnings announcements disclosed during the morning, the order book might be full of orders far a way from being executed. If these orders are not amended or cancelled, they will affect the calculation of *VWSPREAD* and we could expect to see increase similar to Figure 5.

6.3. Order Book Depth

6.3.1. Depth at Best level

Table 9 presents the variable *BDEPTH* (quoted depth) results during the period of +/-34 half-hour intervals around the earnings announcements. This table is also divided into three parts; full sample, trading and non-trading hours. Sign-test is used in order to determine whether or not observations differ statistically from zero and Wilcoxon rank-sum test when comparing whether two subsamples differ from each other.

The full sample results in Table 9 show that the quoted depth is positive and statistically different from zero (at 1 percent level) after the disclosure of earnings announcements (period [0] onwards). These results are in contradiction to the second part of the Hypothesis I, which predicted that the pre-announcement period quoted depths will be lower than in the non-announcement period and that this effect would persist into the

post-announcement period and results of Libby, Mathieu and Robb (2002) that the quoted depth is negative before the earnings announcements. However my results support the findings of Libby, Mathieu and Robb (2002) and Pronk (2006), both of whom find that the specialists' quoted depth is positive after the disclosure of earnings announcements.

Table 9.
Depth at Best Level

This table presents the changes in variable *BDEPTH* during the period of +/- 34 half-hour intervals around the earnings announcement. *BDEPTH* is calculated as time-weighted average of number of orders at the best bid and ask levels during the announcement period, divided by same time, non-announcement -period mean value. Announcement period is divided into 15 parts presented in the first row and the table is further divided into three parts. First part, rows three to six, present the full sample divided into annual and quarterly earnings announcements. Second part, rows seven to ten present the results from earnings announcements made during trading hours. In the third part, rows eleven to fourteen, results from the outside trading hours earnings announcements are presented. Last row presents the statistical difference between during and outside trading hour's earnings announcements. Sign-test and Wilcoxon rank-sum test are used when applicable. Following signs for statistical significance are used:

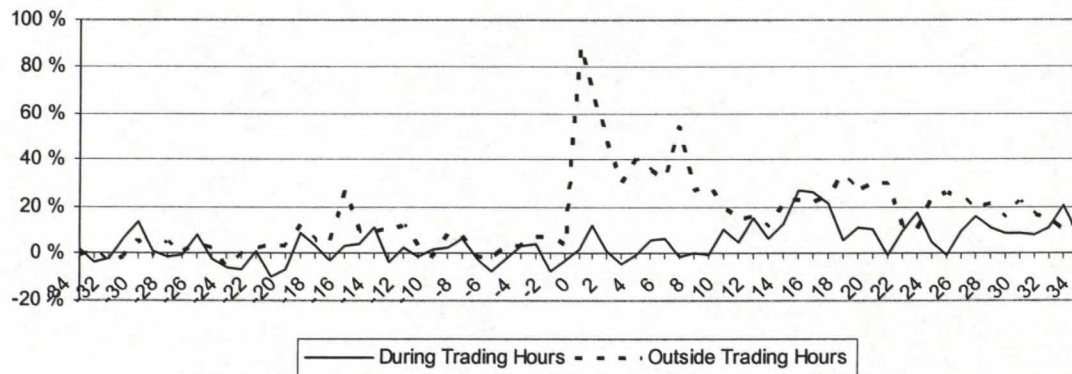
*** Significantly different from 0 at 1% level
 ** Significantly different from 0 at 5% level
 ‡ Significant at 1% level
 † Significant at 5% level

	Median Values														
	[-34,-31]	[-30,-26]	[-25,-21]	[-20,-16]	[-15,-11]	[-10,-6]	[-5,-1]	[0]	[1, 5]	[6,10]	[11,15]	[16,20]	[21,25]	[26,30]	[31,34]
Full Sample	-0.01	0.04	-0.01	0.05***	0.05***	0.01	0.02	0.44***	0.24***	0.16***	0.16***	0.22***	0.14***	0.16***	0.13***
Annual	0.22***	0.24***	0.10***	0.16***	0.17***	0.07***	0.03	0.39***	0.33***	0.13***	0.25***	0.26***	0.18***	0.21***	0.22***
Quarterly	-0.05**	-0.05**	-0.06**	0.02	0.02	-0.02	0.01	0.43***	0.19***	0.17***	0.10***	0.18***	0.12***	0.10***	0.09***
Annual vs. Quarterly	‡	‡	‡	‡	‡	†			‡		‡	‡		†	‡
During Trading Hours	0.01	0.05	-0.05	0.01	0.03	0.01	-0.01	0.02	0.02	0.01	0.13***	0.18***	0.08**	0.11***	0.10***
Annual	0.23***	0.32***	0.06	0.14***	0.22***	0.06***	0.01	-0.02	0.16**	0.02	0.31***	0.22***	0.12	0.17***	0.11**
Quarterly	-0.08	-0.04**	-0.09**	-0.03	-0.03	-0.02	-0.03	0.06	-0.02	0.01	0.07***	0.11***	0.05	0.09***	0.10***
Annual vs. Quarterly	‡	‡		‡	‡	†			‡		‡				
Outside Trading Hours	-0.01	0.03	0.01	0.11***	0.09***	0.01	0.05**	0.89***	0.45***	0.32***	0.18***	0.27***	0.19***	0.21***	0.14***
Annual	0.15**	0.22***	0.15***	0.22***	0.16	0.07**	0.08**	0.64***	0.47***	0.24***	0.22***	0.35***	0.22***	0.29***	0.40***
Quarterly	-0.04**	-0.03	-0.03	0.07**	0.07***	-0.02	0.04	0.96***	0.42***	0.35***	0.16***	0.26***	0.18***	0.18***	0.08***
Annual vs. Quarterly	‡	‡	‡	‡											‡
During vs. Off hours				†	†		†	‡	‡	‡		‡	‡	†	

Table 9 also provides evidence that quoted depths are statistically larger if earnings announcement is of annual type and that this difference tends to larger before the disclosure of outside trading hours earnings announcement. This is in contradiction to Hypothesis II, which predicted that there would be no difference in quoted depths between annual and quarterly earnings announcements. However, my findings are in line with Libby, Mathieu and Robb (2002) results that the quoted depth is larger after annual earnings announcements than after quarterly earnings announcements.

Figure 6 presents the difference in the quoted depth between during (solid line) and outside (dash line) trading hours earnings announcements. Although Table 9 and Figure 6 both provide evidence that quoted depth during pre-announcement period may differ between earnings announcement disclosed during and outside trading hours, the most significant difference is founded during periods [0, 10]. During this period the quoted depth is statistically significantly higher if the announcement is made outside trading hours. This investor's willingness to offer larger amounts of shares after the outside trading hour's earnings announcement indicates that the information asymmetry is much lower when the announcement is made outside trading hours.

Figure 6.
During vs. Outside Trading Hours Depth at Best Level



The results presented in Figure 6 provide clear evidence against the second part of the Hypothesis III, which predicted that quoted depths would remain lower if earnings announcement is disclosed outside trading hours. It is also opposite to the results of Libby, Mathieu and Robb (2002), who found evidence that when earnings are disclosed outside trading hours, specialist quoted depth remains negative and significant during the first 10 half-hour periods. However, my results confirm the findings of Pronk (2006) that quoted depths between during and outside trading hours announcements would differ in favor of outside trading hours earnings announcements.

6.3.2. Total Depth

Table 10 presents the variable TDEPTH (total order book depth) results during the period of +/-34 half-hour intervals around the earnings announcements. Once again this table is divided into three parts; full sample, trading and non-trading hours. Sign-test is used in order to determine whether or not observations differ statistically from zero and Wilcoxon rank-sum test when comparing whether two subsamples differ from each other's.

Table 10.
Total Order Book Depth

This table presents the changes in the total order book depth (*TDEPTH*) during the period of +/- 34 half-hour intervals around the earnings announcement. TDepth is calculated as time-weighted average number of orders in the order book during the announcement period, divided by same time, non-announcement -period mean value. Announcement period is divided into 15 parts presented in the first row and the table is further divided into three parts. First part, rows three to six, present the full sample divided into annual and quarterly earnings announcements. Second part, rows seven to ten present the results from earnings announcements made during trading hours. In the third part, rows eleven to fourteen, results from the outside trading hours earnings announcements are presented. Last row presents the statistical difference between during and outside trading hour's earnings announcements. Sign-test and Wilcoxon rank-sum test are used when applicable. Following signs for statistical significance are used:

*** Significantly different from 0 at 1% level
 ** Significantly different from 0 at 5% level
 ‡ Significant at 1% level
 † Significant at 5% level

	Median Values														
	[-34 -31]	[-30 -26]	[-25 -21]	[-20 -16]	[-15 -11]	[-10 -6]	[-5 -1]	[0]	[1 5]	[6 10]	[11 15]	[16 20]	[21 25]	[26 30]	[31 34]
Full Sample	-0.03***	-0.03***	-0.03***	-0.03***	-0.01	0.00	0.01	0.46***	0.57***	0.54***	0.41***	0.25***	0.24***	0.19***	0.14***
Annual	0.02	0.02	-0.02**	0.00	-0.01	0.01	0.00	0.44***	0.56***	0.56***	0.40***	0.27***	0.26***	0.21***	0.14***
Quarterly	-0.04***	-0.04***	-0.03***	-0.04***	-0.01	-0.01	0.01	0.47***	0.57***	0.53***	0.41***	0.23***	0.24***	0.18***	0.13***
Annual vs. Quarterly	‡													†	
During Trading Hours	-0.02**	-0.01	-0.04***	-0.03***	-0.01	-0.02	-0.01	0.20***	0.37***	0.35***	0.18***	0.15***	0.14***	0.09***	0.06***
Annual	0.12***	0.03	-0.03	0.01	0.01	0.02	0.02	0.32***	0.54***	0.51***	0.28***	0.26***	0.19***	0.14***	0.07***
Quarterly	-0.05***	-0.03	-0.04**	-0.05***	-0.03**	-0.03**	-0.02	0.16***	0.32***	0.28***	0.15***	0.13***	0.13***	0.07***	0.06***
Annual vs. Quarterly	‡	‡		†		†			‡	‡	‡	‡	‡	‡	‡
Outside Trading Hours	-0.03***	-0.04***	-0.03***	-0.02**	-0.01	0.02	0.01	0.68***	0.75***	0.74***	0.68***	0.34***	0.35***	0.33***	0.26***
Annual	-0.03**	0.00	-0.01	-0.01	-0.03**	0.01	-0.01	0.57***	0.61***	0.67***	0.60***	0.29***	0.35***	0.36***	0.27***
Quarterly	-0.03**	-0.04***	-0.03***	-0.02**	0.00	0.03	0.02**	0.74***	0.79***	0.78***	0.72***	0.36***	0.35***	0.33***	0.25***
Annual vs. Quarterly															
During vs. Off hours			†			‡		‡	‡	‡	‡	‡	‡	‡	‡

Based on the full sample results, total depth seems to be slightly negative during periods [-34, -16], approximately 2 days before the announcement. This observation is persistent during and outside trading hours subsamples and seems to be driven by quarterly earnings announcements. Results in Table 10 provide further evidence against

Hypothesis I. As quoted depth, total order book depth increases significantly immediately after the earnings announcement is disclosed and is positive and statistically significant (at 1 percent level) during periods [0, 34]. Moreover, full sample total depth does not peak immediately after the earnings announcement is disclosed, but during period [1, 5]. This indicates that investors also seem to value the price information observed immediately after the disclosure of the earnings announcement.

Interestingly, in accordance with the Hypothesis II, there seems to be hardly any difference in the full sample annual and quarterly earnings announcements. However, if the earnings announcement is disclosed during trading hours, the total order book depth is statistically significantly larger when the announcement is an annual earnings announcement. This investor's increased willingness to provide liquidity after annual earnings announcements disclosed during trading hours might be related to increased volatility observed in this subsample.

Figure 7 presents the total order book depth between during (solid line) and outside (dash line) trading hours earnings announcements. The percentage deviation from non-announcement period mean value is presented on y-axis and half-hour periods around earnings announcement in x-axis.

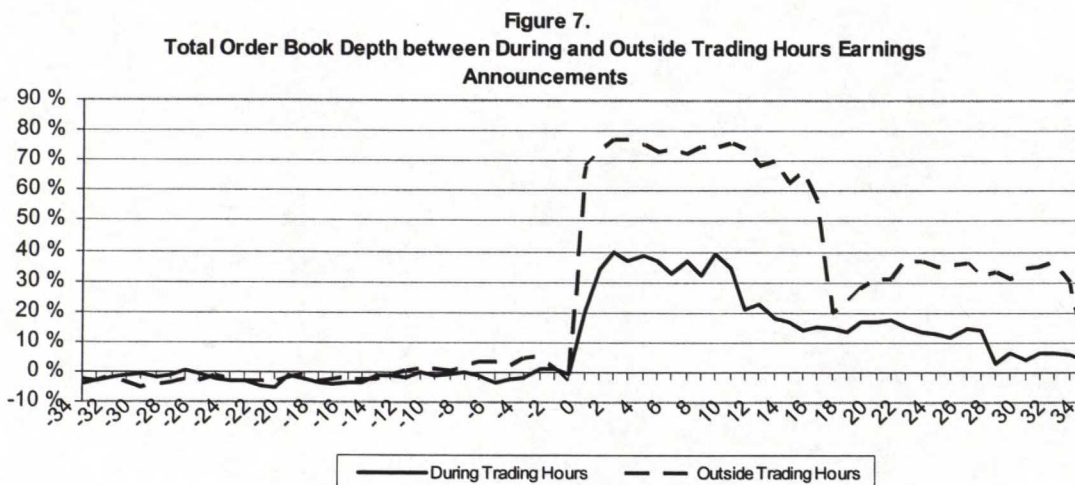


Figure 7 shows that investors are more willing to provide liquidity after outside trading hours earnings announcements than after during trading hours earnings announcements and that this effect continues into the second trading day after the earnings announcement. Figure 7 also highlights the fact that regardless of the time of the earnings announcements disclosure, order book depth is slightly, although not always statistically significantly, negative two days before the announcement moment.

6.3.3. SMARTS Liquidity Formula

Table 11 presents the variable *LIQUID* (SMARTS Liquidity formula) results during the period of +/-34 half-hour intervals around the earnings announcements. This table is also divided into three parts; full sample, trading and non-trading hours. Sign-test is used in order to determine whether or not observations differ statistically from zero and Wilcoxon rank-sum test when comparing whether two subsamples differ from each other.

The results shown in the Table 11 provide further support for the rejection of the Hypothesis I. Liquidity provided at 5 percentage around the midpoint price is positive and statistically significant from period [-15] onwards. As total depth, full sample liquidity does not peak immediately after the disclosure of the earnings announcement, but during period [1, 5], supporting the finding that investors tend to wait and see the price reaction before disclosing their full demand. Just like total order book depth, liquidity offered around the midpoint price differs statistically in favor of annual earnings announcements. providing support against Hypothesis II. The support that difference in liquidity provided around annual and quarterly earnings announcements disclosed during trading hours is larger than if the earnings announcement is made outside trading hours is also provided in Table 11.

Table 11.
SMARTS Liquidity Formula

This table presents the changes in SMARTS liquidity formula (*LIQUD*) during the period of +/- 34 half-hour intervals around the earnings announcement. *LIQUD* is calculated as weighted deviation from midpoint price so that order 5 percentages distance gets weight 0 and order at midpoint price gets weight 1. Announcement period value is divided by non announcement period mean value. Announcement period is divided into 15 parts presented in the first row. Table is divided into three parts. First part, rows three to six, present the full sample divided into annual and quarterly earnings announcements. Second part, rows seven to ten present the results from earnings announcements made during trading hours. In the third part, rows eleven to fourteen, results from the outside trading hours earnings announcements are presented. Last row presents the statistical difference between during and outside trading hours announcements. Sign-test and Wilcoxon rank-sum test are used when applicable. Following signs for statistical significance are used:

*** Significantly different from 0 at 1% level
 ** Significantly different from 0 at 5% level
 ‡ Significant at 1% level
 † Significant at 5% level

	Median Values														
	[-34 -31]	[-30 -26]	[-25 -21]	[-20 -16]	[-15 -11]	[-10 -6]	[-5 -1]	[0]	[1 5]	[6 10]	[11 15]	[16 20]	[21 25]	[26 30]	[31 34]
Full Sample	-0.01	-0.01	-0.01	-0.01	0.02***	0.05***	0.03***	0.46***	0.58***	0.51***	0.42***	0.29***	0.27***	0.23***	0.18***
Annual	0.12***	0.11***	0.04**	0.06***	0.06***	0.09***	-0.04***	0.45***	0.57***	0.57***	0.48***	0.38***	0.30***	0.29***	0.25***
Quarterly	-0.06***	-0.05***	-0.03***	-0.03***	-0.01	0.03***	0.02	0.49***	0.58***	0.46***	0.38***	0.26***	0.25***	0.19***	0.15***
Annual vs. Quarterly	‡	‡	‡	‡	‡	‡				‡	†	‡	‡	‡	‡
During Trading Hours	0.03	0.03	-0.03***	-0.01	0.02**	0.01	-0.03**	0.15***	0.31***	0.32***	0.23***	0.25***	0.18***	0.14***	0.06***
Annual	0.25***	0.14***	0.00	0.07***	0.11***	0.07**	0.01	0.25***	0.42***	0.45***	0.39***	0.35***	0.27***	0.26***	0.18***
Quarterly	-0.05***	-0.04***	-0.06***	-0.07***	-0.02	-0.02	-0.05***	0.09**	0.27***	0.26***	0.17***	0.16***	0.13***	0.07***	0.01
Annual vs. Quarterly	‡	‡	†	‡	‡	‡			‡	‡	‡	‡	‡	‡	
Outside Trading Hours	-0.03**	-0.03	0.01	0.01	0.03**	0.07***	0.06***	0.93***	0.79***	0.72***	0.60***	0.34***	0.37***	0.31***	0.25***
Annual	-0.08**	0.07***	0.07***	0.05**	0.04**	0.10***	0.08***	0.77***	0.72***	0.67***	0.61***	0.39***	0.42***	0.38***	0.36***
Quarterly	-0.07***	-0.06***	-0.01	-0.01	0.02	0.06***	0.06***	0.95***	0.82***	0.74***	0.59***	0.30***	0.36***	0.28***	0.22***
Annual vs. Quarterly	‡	‡	†	†										†	†
During vs. Off hours	†		‡			‡	‡	‡	‡	‡	‡	‡	‡	‡	‡

Figure 8.
Liquidity Provided Around Earnings Announcements Disclosed During and Outside Trading Hours

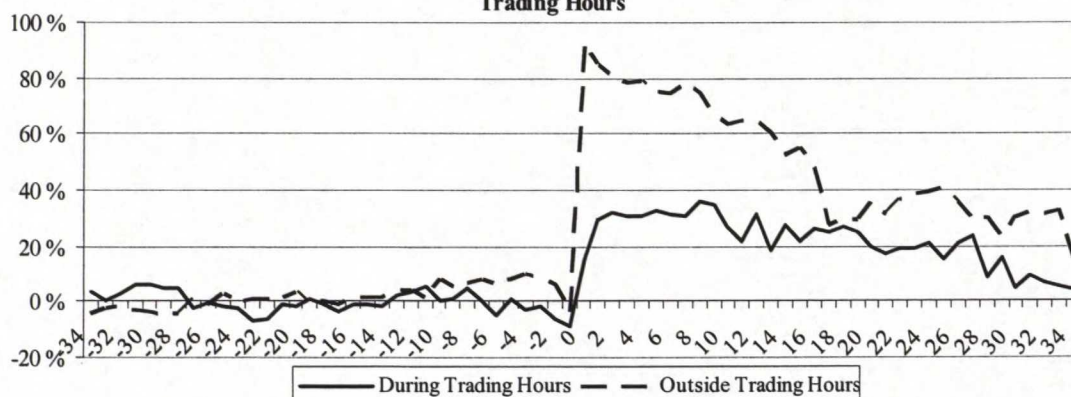


Figure 8 presents variable *LIQUID* development between during (solid line) and outside (dash line) trading hours earnings announcements. Percentage deviation from non-announcement period mean value is presented on y-axis and half-hour periods around earnings announcement in x-axis. As the total order book depth, the offered liquidity is greater if the earnings announcement is disclosed outside trading hours. Although the most significant difference in these two subsamples is observed after the disclosure of earnings announcement, liquidity provided during outside trading hours earnings announcements is statistically significantly higher from period [-10, -6] onwards. This is earlier than variable *TDEPTH* indicated and suggest that the difference between during and outside trading hours earnings announcements starts already before the disclosure of the earnings news.

6.4. *Information Asymmetry*

Kim and Verrecchia (1994) modeled how information asymmetry affects the trading around earnings announcements. They suggested that there may be more information asymmetry at the time of an announcement than during the non-announcement period and that this increased information asymmetry should show as increase in bid-ask spread and decrease in quoted depth. In accordance, Hypothesis I predicted that in the period just before earnings are announced (the pre-announcement period), quoted spreads would be wider and quoted depths will be lower than in the non-announcement period and that this effect would persist into the period just after earnings are announced (the post-announcement period). Table 12 below presents a summary of the variables used to tackle this question.

According to Panel A in Table 10, both *VWSPREAD* and *SPREAD* are either statistically insignificant or statistically significant and slightly positive during the pre-announcement period. This is in contradiction to the Hypothesis and Kim and Verrecchia (1994) theory, suggesting that information asymmetry would increase before the disclosure of earnings announcement. During the half-hour, period [0], including the earnings announcement, both variables are positive and statistically significant, supporting the Hypothesis

prediction that spreads would be wider during the period just after the earnings are announced. However, during the post-announcement period the variable *SPREAD* is negative and statistically significant for the most of the observation period. Although this partly supports the Hypothesis, the rapid decline in *SPREAD* suggests that information asymmetry caused by the earnings announcement is rapidly solved by market participants. This evidence documented is opposite to findings of Libby, Mathieu and Robb (2002) who found that spread is positive and statistically significant, before the disclosure of earnings announcement and after the announcement first positive, but statistically insignificant and then negative and statistically significant.

Table 12.
Full Sample Order Book Depth and Spread Variables

This table is a summary table highlighting the changes in order book spread and depth around earnings announcements. Variables; volume weighted spread (*VWSPREAD*), spread (*SPREAD*), total order book depth (*TDEPTH*), depth at best levels (*BDEPTH*) and Smarts liquidity formula (*LIQUID*) are defined in Chapter 5.1. Only full sample values are presented in this table, for details in each variable, please refer to Chapter 5. Table is divided into two panels, Panel A presents the spread variables; *VWSPREAD* and *SPREAD* while order book depth variables; *TDEPTH*, *BDEPTH* and *LIQUID* are presented in Panel B. Announcement period is divided into 15 parts. Following signs for statistical significance are used:

*** Significantly different from 0 at 1% level

** Significantly different from 0 at 5% level

Panel A: Volume weighted spread and bid-ask spread

	Median Values														
	[-34 -31]	[-30 -26]	[-25 -21]	[-20 -16]	[-15 -11]	[-10 -6]	[-5 -1]	[0]	[1 5]	[6 10]	[11 15]	[16 20]	[21 25]	[26 30]	[31 34]
VWSPREAD	0,01**	0,02***	0,03***	0,02***	0,01	0,00	0,06***	0,04**	0,04***	0,07***	0,05***	0,00	-0,01	0,01**	0,01
SPREAD	0,01	0,01**	-0,01	0,00	-0,01	0,01	0,02	0,97***	-0,04***	-0,07***	-0,08***	0,03**	-0,05***	-0,03***	-0,02

Panel B: Total order book depth, depth at best levels and smarts liquidity volume

	Median Values														
	[-34 -31]	[-30 -26]	[-25 -21]	[-20 -16]	[-15 -11]	[-10 -6]	[-5 -1]	[0]	[1 5]	[6 10]	[11 15]	[16 20]	[21 25]	[26 30]	[31 34]
TDEPTH	-0,03***	-0,03***	-0,03***	-0,03***	-0,01	0,00	0,01	0,46***	0,57***	0,54***	0,41***	0,25***	0,24***	0,19***	0,14***
BDEPTH	-0,01	0,04	-0,01	0,05***	0,05***	0,01	0,02	0,44***	0,24***	0,16***	0,16***	0,22***	0,14***	0,16***	0,13***
LIQUID	-0,01	-0,01	-0,01	-0,01	0,02***	0,05***	0,03***	0,46***	0,58***	0,51***	0,42***	0,29***	0,27***	0,23***	0,18***

The second part of the Hypothesis I predicted that in the period just before the earnings are announced order book depth would be lower than in the non-announcement period and that this effect would persist into the period just after earnings are announced. Results presented in Panel B of Table 10, show that all the variables (*TDEPTH*, *BDEPTH* and *LIQUID*) are positive and statistically significant from period [0] onwards, suggesting that order book depth increases in all levels after the earnings announcement. Further

evidence for the rejection of the Hypothesis provides *LIQUID*, liquidity 5% around midpoint price, which is positive and statistically significant from period [-15] onwards. These findings are also in contradiction to Libby, Mathieu and Robb (2002), who document negative and statistically significant values for depth immediately around the earnings announcement.

The overall effect of the results provided in Table 10 seems to be that liquidity (the combination of both spread and depth variables) is changed only little before the earnings announcement and significantly improved after the disclosure. This leads to the rejection of the Hypothesis I. The only thing supporting the increase in information asymmetry is the quoted spread, which peaks during the half-hour including the earnings announcement. Interestingly, variable *VWSPREAD* is slightly positive and statistically significant around the disclosure of the earnings announcement. Indicating that the overall liquidity offered is reduced slightly during that period.

One of the probable reasons why the results from variables *SPREAD* and *VWSPREAD* differ relates to their composition. While variable *SPREAD* investigates changes in the bid-ask spread, which may consist of only few shares, variable *VWSPREAD* measures the changes between volume-weighted bid and ask prices, consisting of the aggregate volumes of both bid and ask sides of the order book. Therefore it is possible that *VWSPREAD* would describe the actions of larger and probably more sophisticated investors better and would thus match better to the behavior of specialists' actions. Nevertheless, results provide quite strong evidence that in market wide settings pre-announcement spreads and depths do not differ significantly from non-announcement period, while during the post-announcement period spreads would be narrower and depths higher.

6.5. *Annual vs. Quarterly Earnings Announcements*

Some of the early research on earnings announcements suggested that information asymmetry might be solved in different degrees depending on whether the earnings announcement is of annual or quarterly type (Jones and Bublitz (1990), Mendenhall and Nichols (1988) and Givoly and Ronen (1981)). Libby, Mathieu and Robb (2002) hypothesized that this difference would still prevail, but were only able to document that quoted depth was significantly smaller around quarterly earnings announcement. In Hypothesis II, it was predicted that there would be no difference between relative spreads and relative depths before the announcement of quarterly earnings news and before the announcement of annual earnings news. Table 13 presents the differences between full sample annual and quarterly announcements for variables; volume weighted spread (*VWSPREAD*), spread (*SPREAD*), total order book depth (*TDEPTH*), depth at best levels (*BDEPTH*) and Smarts liquidity formula (*LIQUD*). Further details about each variable can be found in respective sections of this chapter.

Panel A in Table 13 provides evidence supporting the null Hypothesis that spreads between annual and quarterly earnings announcements do not differ. Although variable *VWSPREAD* shows modest indication of wider spreads approximately two days before quarterly earnings announcement (period [-34, -11]), there seems to be hardly any difference in variables *SPREAD* and *VWSPREAD* right before the disclosure of the earnings announcement. This observation supports both the discussion in Chapter 3.6 indicating that increased regulation has improved the quality of the quarterly earnings announcements and Libby, Mathieu and Robb (2002) evidence.

Panel B in Table 13 shows that total order book depth (*TDEPTH*) is little affected by the announcement type, supporting Hypothesis II. However, variables *BDEPTH* and *LIQUD* provide evidence that liquidity around midpoint price is significantly improved if the announcement is annual earnings announcement. The improvement in quoted depth around annual earnings announcement supports the findings of Libby, Mathieu and Robb

Table 13.

Full Sample Annual vs. Quarterly Earnings Announcements

This table is a summary table highlighting the changes in order book spread and depth around annual and quarterly earnings announcements. Variables; volume weighted spread (*VWSPREAD*), spread (*SPREAD*), total order book depth (*TDEPTH*), depth at best levels (*BDEPTH*) and Smarts liquidity formula (*LIQUD*) are defined in Chapter 5.1. For further details in each variable, please refer to Chapter 6. The table is divided into two panels, Panel A presents the spread variables; *VWSPREAD* and *SPREAD* while order book depth variables; *TDEPTH*, *BDEPTH* and *LIQUD* are presented in Panel B. Announcement period is divided into 15 parts. The following signs for statistical significance between the figures are used:

- ‡ Significant at 1% level
† Significant at 5% level
*** Significantly different from 0 at 1% level
** Significantly different from 0 at 5% level

Panel A: Volume weighted spread and bid-ask spread

	Median Values														
	[-34 -31]	[-30 -26]	[-25 -21]	[-20 -16]	[-15 -11]	[-10 -6]	[-5 -1]	[0]	[1 5]	[6 10]	[11 15]	[16 20]	[21 25]	[26 30]	[31 34]
<i>VWSPREAD</i>															
Annual	-0,07***	-0,06***	-0,01	-0,02**	-0,03***	-0,01	0,06***	0,08	0,11***	0,11***	0,03***	-0,02	-0,02	0,00	0,00
Quarterly	0,04***	0,05***	0,05***	0,03***	0,02***	0,01	0,05***	0,03	0,03***	0,06***	0,05***	0,00	-0,01	0,01**	0,01
Annual vs. Quarterly	‡	‡	‡	‡	‡				‡	‡					
<i>SPREAD</i>															
Annual	-0,08***	-0,02	-0,05	0,00	0,00	-0,03	0,05**	1,00***	-0,04	-0,07***	-0,05***	-0,08***	-0,08***	-0,05***	-0,06***
Quarterly	0,03***	0,03***	0,00	0,00	-0,01	0,02**	0,01	0,97***	-0,04***	-0,07***	-0,08***	-0,01	-0,04***	0,03**	0,00
Annual vs. Quarterly	‡		†			†						†	†		

Panel B: Total order book depth, depth at best levels and smarts liquidity volume

	Median Values														
	[-34 -31]	[-30 -26]	[-25 -21]	[-20 -16]	[-15 -11]	[-10 -6]	[-5 -1]	[0]	[1 5]	[6 10]	[11 15]	[16 20]	[21 25]	[26 30]	[31 34]
<i>TDEPTH</i>															
Annual	0,02	0,02	-0,02**	0,00	-0,01	0,01	0,00	0,44***	0,56***	0,56***	0,40***	0,27***	0,26***	0,21***	0,14***
Quarterly	-0,04***	-0,04***	-0,03***	-0,04***	-0,01	-0,01	0,01	0,47***	0,57***	0,53***	0,41***	0,23***	0,24***	0,18***	0,13***
Annual vs. Quarterly		‡												†	
<i>BDEPTH</i>															
Annual	0,22***	0,24***	0,10***	0,16***	0,17***	0,07***	0,03	0,39***	0,33***	0,13***	0,25***	0,26***	0,18***	0,21***	0,22***
Quarterly	-0,05**	-0,05**	-0,06**	0,02	0,02	-0,02	0,01	0,43***	0,19***	0,17***	0,10***	0,18***	0,12***	0,10***	0,09***
Annual vs. Quarterly	‡	‡	‡	‡	‡	†			‡		‡	‡		†	‡
<i>LIQUD</i>															
Annual	0,12***	0,11***	0,04**	0,06***	0,06***	0,09***	-0,04***	0,45***	0,57***	0,57***	0,48***	0,38***	0,30***	0,29***	0,25***
Quarterly	-0,06***	-0,05***	-0,03***	-0,03***	-0,01	0,03***	0,02	0,49***	0,58***	0,46***	0,38***	0,26***	0,25***	0,19***	0,15***
Annual vs. Quarterly	‡	‡	‡	‡	‡	‡				‡	†	‡	‡	‡	‡

(2002). Although the evidence provided in Table 13 leads to the acceptance of Hypothesis II, it appears that annual earnings announcements attract more attention

among investors than quarterly earnings announcements. This increased interest among investors is observed through improved liquidity (through order book depth), increased trading volumes and typical trade size, but also through increase in intraday volatility.

The fact that investors seem to be more active around annual earnings announcements than around quarterly earnings announcement may have several explanations. First of all, companies listed in Helsinki Stock Exchange tend to disclose their dividend proposals along with their annual earnings announcement. This announcement may help investors to analyze the possibilities to capture potential ex-dividend day returns documented by several academics¹. Secondly, annual earnings announcements often contain other proposals such as proposal to buyback shares, or proposal for new board members, which may activate investors.

6.6. *During vs. Outside Trading Hours Announcements*

The mixed results of Libby, Mathieu and Robb (2002) and Pronk (2006) led Hypothesis III to predict that relative spreads would remain wider and relative depths would remain lower for a longer period of time when earnings announcements occur outside trading hours than when they occur during trading hours. Table 14 presents summary of the differences between during and outside trading hours earnings announcements for variables; volume weighted spread (*VWSPREAD*), spread (*SPREAD*), total order book depth (*TDEPTH*), depth at best levels (*BDEPTH*) and Smarts liquidity formula (*LIQUD*). Further details about each variable can be found in respective sections in Chapter 5.

The evidence from Helsinki Stock Exchange provides clear and contradicting evidence against the Hypothesis III and Libby, Mathieu and Robb (2002) findings, while the support the findings of Pronk (2006). The results in table 14 show, that if the earnings announcement is disclosed outside trading hours both variables *VWSPREAD* and *SPREAD* are narrower than if the earnings announcement is disclosed during trading

¹ For instance, Bell and Jenkinson (2000), Kalay (1982) and Michaely (1991).

Table 14.
Outside vs. During Trading Hours Earnings Announcements

This table is a summary table highlighting the differences in order book spread and depth around during and outside trading hours earnings announcements. Variables; volume weighted spread (VWSPREAD), spread (SPREAD), total order book depth (TDEPTH), depth at best levels (BDEPTH) and Smarts liquidity formula (LIQUID) are defined in Chapter 5.1. For further details in each variable, please refer to respective section in Chapter 6. Table is divided into two panels, Panel A presents the spread variables; VWSPREAD and SPREAD while order book depth variables; TDEPTH, BDEPTH and LIQUID are presented in Panel B. Announcement period is divided into 15 parts. Following signs for statistical significance between the figures are used:

‡ Significant at 1% level
† Significant at 5% level
*** Significantly different from 0 at 1% level
** Significantly different from 0 at 5% level

Panel A: Volume weighted spread and bid-ask spread

	Median Values														
	[-34 -31]	[-30 -26]	[-25 -21]	[-20 -16]	[-15 -11]	[-10 -6]	[-5 -1]	[0]	[1 5]	[6 10]	[11 15]	[16 20]	[21 25]	[26 30]	[31 34]
VWSPREAD															
During Trading Hours	0,02	0,02**	0,05***	0,03***	0,03***	0,06***	0,15***	0,18***	0,13***	0,13***	0,04***	0,00	0,01	0,02**	0,02**
Outside Trading Hours	0,01	0,01	0,02	0,01	-0,01	-0,03***	0,01	-0,08***	-0,03***	0,02**	0,05***	-0,01	-0,03***	0,00	0,00
During vs. Off hours			‡	‡	†	‡	‡	‡	‡	‡			‡		
SPREAD															
During Trading Hours	0,00	0,02	0,00	0,02	0,01	0,02**	0,07***	0,66***	-0,05***	0,02	-0,03	-0,04	0,00	0,02	-0,03***
Outside Trading Hours	0,02	0,01	-0,02	-0,01	-0,03**	-0,01	-0,03**	2,88***	-0,12***	-0,13***	-0,12***	-0,02	-0,09***	-0,08***	0,01
During vs. Off hours					‡		‡	‡	‡	‡	‡	‡	‡	‡	†

Panel B: Total order book depth, depth at best levels and smarts liquidity volume

	Median Values														
	[-34 -31]	[-30 -26]	[-25 -21]	[-20 -16]	[-15 -11]	[-10 -6]	[-5 -1]	[0]	[1 5]	[6 10]	[11 15]	[16 20]	[21 25]	[26 30]	[31 34]
TDEPTH															
During Trading Hours	-0,02**	-0,01	-0,04***	-0,03***	-0,01	-0,02	-0,01	0,20***	0,37***	0,35***	0,18***	0,15***	0,14***	0,09***	0,06***
Outside Trading Hours	-0,03***	-0,04***	-0,03***	-0,02**	-0,01	0,02	0,01	0,68***	0,75***	0,74***	0,68***	0,34***	0,35***	0,33***	0,26***
During vs. Off hours			†			‡		‡	‡	‡	‡	‡	‡	‡	‡
BDEPTH															
During Trading Hours	0,01	0,05	-0,05	0,01	0,03	0,01	-0,01	0,02	0,02	0,01	0,13***	0,18***	0,08**	0,11***	0,10***
Outside Trading Hours	-0,01	0,03	0,01	0,11***	0,09***	0,01	0,05**	0,89***	0,45***	0,32***	0,18***	0,27***	0,19***	0,21***	0,14***
During vs. Off hours				†	†		†	‡	‡	‡		‡	‡	†	
LIQUID															
During Trading Hours	0,03	0,03	-0,03***	-0,01	0,02**	0,01	-0,03**	0,15***	0,31***	0,32***	0,23***	0,25***	0,18***	0,14***	0,06***
Outside Trading Hours	-0,03**	-0,03	0,01	0,01	0,03**	0,07***	0,06***	0,93***	0,79***	0,72***	0,60***	0,34***	0,37***	0,31***	0,25***
During vs. Off hours	†		‡			‡	‡	‡	‡	‡	‡	‡	‡	‡	‡

hours. The only period supporting Hypothesis III is period [0], immediately after the disclosure of the earnings announcement. During that period, the spread is statistically significantly wider if the earnings announcement is disclosed outside trading hours. However, variables *TDEPTH*, *BDEPTH* and *LIQUID* all provide unanimous evidence

against Hypothesis III, indicating that order book depth, at all levels, is higher if the announcement is disclosed outside trading hours. Results from other variables also provide further support for the rejection of the hypothesis. For announcements disclosed outside trading hours, both trading volume and average trade value are higher and statistically significantly different from during trading hours subsample. Moreover, variable *VOLA* (volatility) provides modest indication that intraday volatility around earnings announcements disclosed during trading hours is higher, indicating increased uncertainty among investors.

Kim and Verrecchia (1994) suggested that increase in information asymmetry would lead to reduction in liquidity and increase in trading volumes. The evidence provided in this paper suggests that the decision to disclose earnings outside trading hours reduces the information asymmetry among market participants. However, the increase in trading volumes after outside trading hours announcements suggests that while those capable of informed judgements would, most certainly, be worse off if the disclosure of earnings announcements would be prohibited, the overall liquidity of the market would improve.

7. Correlation Coefficients

Table 15 presents the Spearman correlation coefficients for the variables defined in Chapter 5.1. The Spearman correlation coefficients indicate moderate negative correlation between *SPREAD* and variables *BDEPTH*, *TDEPTH* and *LIQUID*, and on the other hand between *VWSPREAD* and variables *BDEPTH*, *TDEPTH* and *LIQUID*. This negative correlation between spread and depth is strongest when using aggregate variables *VWSPREAD* and *LIQUID*. These results support Pronk (2006) evidence of negative correlation between specialist quoted spread and depth in market wide settings. Pronk (2006) argues that negative correlation between spread and depth suggests that specialist's adjustments to the depth and spread are related.

Moreover, Table 15 provides evidence that volatility (*VOLA*) has moderate positive correlation with variables *SPREAD*, *VWSPREAD*, *VOLUME* and *AVT* (average trade value). Although one would expect to find positive correlation between volatility and trading volume and on the other hand between volatility and bid-ask spread, it is little disturbing to find evidence that volatility and average trade value have a positive correlation. This could be due to the investors' willingness to trade in times of high volatility, but might also be affected by strong positive correlation between *VOLUME* and *AVT*.

Table 15.
Spearman Correlation Coefficients

This table contains the Spearman correlation coefficients. The variables are defined in the Chapter 5.1. *** indicates significance at the 1 percent level (two-tailed tests).

	SPREAD	TDEPTH	BDEPTH	LIQUID	VWSPREAD	VOLUME	VOLA	ATV	INITIMB
SPREAD	1								
TDEPTH	-0.09***	1							
BDEPTH	-0.17***	0.30***	1						
LIQUID	-0.19***	0.84***	0.41***	1					
VWSPREAD	0.21***	-0.08***	-0.28***	-0.44**	1				
VOLUME	-0.03***	-0.38***	0.31***	0.36***	-0.04***	1			
VOLA	0.39***	0.09***	-0.11***	-0.02***	0.20***	0.38***	1		
ATV	0.00	0.26***	0.36***	0.30***	-0.12***	0.76***	0.20***	1	
INITIMB	-0.02***	0.01	0.01	0.02***	-0.03***	0.03***	0.00	0.05***	1

Another interesting result is that *VOLUME* and total order book depth (*TDEPTH*) have moderate negative correlation, while *VOLUME* has moderate positive correlation with depth at best level (*BDEPTH*) and *LIQUID*. This could be an indication that an increase in total order book depth does not lead to increase in trading volume, but that an increase in trading volume requires an increase in depth close to the midpoint price. Further evidence for this relationship provides moderate positive correlation between *AVT* and variables *TDEPTH*, *BDEPTH* and *LIQUID*.

The results also provide evidence that the variable *INITIMB* does not correlate with any other variable and those variables with close dependency of each other, *LIQUID*, *TDEPTH* and *BDEPTH* and on the other hand *SPREAD* and *VWSPREAD* correlate positively with each other.

8. Multivariate Results

Table 16 presents the regression results from the models described in Chapter 5.2. Table is divided into three parts. Two- stage least squares model estimating equation (10), where relative depth is the dependant variable is presented in columns three and four. Two- stage least squares model estimating equation (11), where relative spread is dependant variable is presented in columns five and six. Comparison to ordinary least squares model (OLS) is presented in columns seven and eight. Column two presents the expected signs for each variable (justification for expected signs is presented in Chapter 5.2).

Given that, the results interpretation in relation to Hypothesis I and II is dependant on coefficient ANNUAL_BEF, Libby, Mathieu and Robb (2002) suggest the discussing findings related to this interaction term first. The results presented in Table 14 indicate that the coefficient on ANNUAL_BEF is negative and statistically significant on relative depth and positive but statistically insignificant on the relative spread. These results support the findings of the univariate results, which indicated that the quoted order book depth and the total order book depths were larger around annual earnings announcement, but that there was no conclusive evidence to support the fact that order book spread would differ between annual and quarterly earnings announcements. Libby, Mathieu and Robb (2002), based on Aiken and West (1991) recommendations, argue that interpretation of the results is easier if annual and quarterly earnings announcements are analyzed separately.

The results from annual and quarterly earnings announcements are presented in tables 17 and 18, respectively. Tables are divided into three parts. Two- stage least squares model estimating (10), where relative depth is dependant variable is presented in columns three and four. Two- stage least squares model estimating (11), where relative spread is dependant variable is presented in columns five and six. Comparison to ordinary least squares model (OLS) is presented in columns seven and eight.

Table 16.
Two-stages Least Squares and OLS

This table presents the regression results of the regression model specified in Chapter 5.2. In the model all 22.624 observations of +/- 34 half-hour periods around earnings announcements are used.

n = 22 624	Sign*	Two-Stage least squares				OLS	
		Relative Depth		Relative Spread		Relative Spread	
		Coefficient	t-value	Coefficient	t-value	Coefficient	t-value
Intercept	?, ?	0.531	22.92***	0.076	2.54***	0.073	2.39***
RSPREAD	-, na	-0.002	-0.34				
RDEPTH	na, -			-0.005	-0.53	-0.004	-0.51
BEF_AFTER	+, -	0.262	9.01***	-0.177	-4.76***	-0.177	-4.75***
ANNUAL	+, -	0.264	6.72***	-0.093	-1.85**	-0.097	-1.94**
TRADINGH	-, +	0.223	8.91***	-0.034	-1.06	-0.034	-1.05
VARVOL	na, -			-0.001	-0.73	-0.001	-0.73
RVOLUME	+, na	0.011	14.07***				
ANNUAL_BEAF	?, ?	-0.226	-4.087***	0.117	1.643	0.114	1.62
VOLA		-0.069	-11.96***	0.281	40.14***	0.331	43.14***
Adjusted R ²			0.02		0.07		0.07

Notes:

- * The first prediction applies to the model using relative depth as the dependant variable; the second prediction applies to both regressions using relative spread as the dependant variable
- *** Significantly different from 0 at the 1% level
- ** Significantly different from 0 at the 5% level
- RDEPTH_i = relative depth in the event period of observation i;
- RSPREAD_i = relative spread in the event period of observation i;
- BEF/AFTER = a dummy variable equal to 1 for the period after the announcement and 0 otherwise;
- ANNUAL = a dummy variable equal to 1 when announcement is an annual earnings announcement and 0 otherwise;
- TRADINGH = a dummy variable equal to 1 when the announcement is made outside trading hours and 0 otherwise;
- RVOLUME_i = relative volume (in percentage) in the event period of observation i;
- VARVOL = the variance of the relative volume (in percentage) in the event period;
- ANNUAL_BEAF = a multiplicative dummy variable for the variable ANNUAL and BEF/AFTER equal to 1 for the period after an annual announcement and 0 for the period before quarterly announcements, the period before annual announcements, and the period after quarterly announcements
- VOLA_i = relative volatility in the event period of observation i;

The results in Tables 17 and 18 indicate that for relative depth, coefficient on BEF/AFTER is positive and statistically insignificant for annual earnings announcements and positive and statistically significant for quarterly earnings announcements. As for the relative spread, coefficient on BEF/AFTER is negative and statistically significant for both annual and quarterly earnings announcements. These results are in line with

univariate results, which provided evidence that spreads would be wider and depth higher after the disclosure of the earnings announcements.

Table 17.
Two-Stages Least Squares and OLS for Annual Earnings Announcements

This table presents the regression results of the regression model specified in Chapter 5.2. In the model all 6.141 observations of +/- 34 half-hour periods around earnings announcements are used.

n = 6 141	Sign*	Two-Stage least squares				OLS	
		Relative Depth		Relative Spread		Relative Spread	
		Coefficient	t-value	Coefficient	t-value	Coefficient	t-value
Intercept	?, ?	0.689	7.17***	-0.565	2.54***	-0.057	-1.35
RSPREAD	-, na	0.027	2.18***				
RDEPTH	na, -			0.030	-0.53	0.027	2.03***
BEF_AFTER	+, -	0.042	0.90	-0.134	-4.76***	-0.149	-3.10***
TRADINGH	-, +	0.201	4.35***	-0.127	-1.06	-0.132	-2.77***
VARVOL	na, -			-0.004	-0.73	-0.004	-1.39
RVOLUME	+, na	0.006	5.25***				
VOLA		-0.060	-5.96***	0.367	41.15***	0.386	42.59***
Adjusted R ²			0.01		0.29		0.23

Notes:

- * The first prediction applies to the model using relative depth as the dependant variable; the second prediction applies to both regressions using relative spread as the dependant variable
- *** Significantly different from 0 at the 1% level
- ** Significantly different from 0 at the 5% level
- RDEPTH = Relative depth in the event period of observation i;
- RSPREAD = Relative spread in the event period of observation i;
- BEF/AFTER = A dummy variable equal to 1 for the period after the announcement and 0 otherwise;
- TRADINGH = A dummy variable equal to 1 when the announcement is made outside trading hours and 0 otherwise;
- RVOLUME = Relative volume (in percentage) in the event period of observation i;
- VARVOL = The variance of the relative volume (in percentage) in the event period;
- VOLA = Relative volatility in the event period of observation i;

In contradiction to Hypothesis III, the coefficient on *TRADINGH* is positive and statistically significant for relative depth around quarterly and annual earnings announcements. This result, suggesting that if the announcement is disclosed outside trading hours quoted depth is larger is in line with the previous observations made in univariate results. The relative spread coefficient on *TRADINGH* is positive and statistically insignificant for quarterly earnings announcements, but negative and statistically insignificant for annual earnings announcements. Statistically significant

negative observations would have been in line with univariate results and given further support to reject the Hypothesis III.

Table 18.
Two-Stages Least Squares and OLS for Quarterly Earnings Announcements

This table presents the regression results of the regression model specified in chapter 5.2. In the model all 16.491 observations of +/- 34 half-hour periods around earnings announcements are used.

n = 16 491	Sign*	Two-Stage least squares				OLS	
		Relative Depth		Relative Spread		Relative Spread	
		Coefficient	t-value	Coefficient	t-value	Coefficient	t-value
Intercept	?, ?	0.237	4.314***	-0.345	-7.97***	0.099	2.96***
RSPREAD	-, na	-0.007	-1.22				
RDEPTH	na, -			-0.015	-1.47	-0.016	-1.56
BEF_AFTER	+, -	0.248	8.37***	-0.145	-3.66***	-0.139	-3.48***
TRADINGH	-, +	0.222	7.48***	0.003	0.07	0.001	0.02
VARVOL	na, -			0.000	-0.12	0.000	-0.20
RVOLUME	+, na	0.018	14.99***				
VOLA		-0.081	-11.30***	0.211	22.66***	0.221	23.61***
Adjusted R ²			0.03		0.05		0.03

Notes:

- * The first prediction applies to the model using relative depth as the dependant variable; the second prediction applies to both regressions using relative spread as the dependant variable
- *** Significantly different from 0 at the 1% level
- ** Significantly different from 0 at the 5% level
- RDEPTH_i = Relative depth in the event period of observation i;
- RSPREAD_i = Relative spread in the event period of observation i;
- BEF/AFTER = A dummy variable equal to 1 for the period after the announcement and 0 otherwise;
- TRADINGH = A dummy variable equal to 1 when the announcement is made outside trading hours and 0 otherwise;
- RVOLUME_i = Relative volume (in percentage) in the event period of observation i;
- VARVOL = The variance of the relative volume 8in percentage) in the event period;
- VOLA_i = Relative volatility in the event period of observation i;

Coefficient VARVOL is positive and statistically insignificant for quarterly earnings announcements and negative and statistically insignificant for annual earnings announcements. Following Libby, Mathieu and Robb (2002), I had expected negative sign for this coefficient based on the assumption that the high volatility in volume would increase the adverse selection risk faced by market participants. As expected, the coefficient VOLA for both annual and quarterly earnings announcements is negative and statistically significant for relative depth and positive and statistically significant for

relative spread. This supports the assumption that increased volatility decreases the relative depth and increases relative spread as uncertainty among market participants increases. Observations for coefficient RVOLUME are also in line with expectations: coefficient is positive and statistically significant for both annual and quarterly earnings announcements. This supports the assumption that increased volume increases the order book depth.

In general, the results from the regression model support the prior evidence from univariate analysis. The Hypothesis III (wider spreads and lower depths after the earnings announcement disclosed outside trading hours) is also rejected. Coefficient for variable *TRADINGH* indicates that earnings announcements disclosed outside trading hours increase the order book depth, and decrease quoted spread, particularly around annual earnings announcements. However, as for Hypothesis I, the regression model provides confusing evidence. As for relative depth, coefficient on BEF/AFTER is positive and statistically insignificant for annual earnings announcements and positive and statistically significant for quarterly earnings announcements. As for relative spread, coefficient on BEF/AFTER is negative and statistically significant for both annual and quarterly earnings announcements.

9. Conclusions

In this paper I have investigated the earnings announcements effects to the order book in Helsinki Stock Exchange. The purpose of this study has been to find out whether or not the timing of corporate disclosure affects the composition of order book and whether the markets react differently to annual and quarterly earnings announcements. Several variables have been employed by this study in order to verify how market participants react to new information and to document that new information does not only change the composition of bid-ask spread and quoted depth, but also the composition of the whole order book. Other, more descriptive variables, have been used in order to document the changes in trading volume and intraday volatility.

On theoretical front this paper has tackled on information asymmetry and Kim and Verrecchia (1994) argument that information asymmetry would reduce the liquidity, and increase trading volumes around earnings announcements. Further evidence on Francis, Pagach and Stephan (1992) suggestion that the market reaction to daytime and overnight announcement may differ, is also provided. Furthermore, this paper has investigated Libby, Mathieu and Robb (2002) Hypothesis that relative spreads would be wider and relative depths lower around the supposedly less precise quarterly earnings announcement.

In the empirical part, this study has documented the substantial difference between earnings announcements disclosed outside trading and during trading hours. Evidence is provided that spreads, both quoted and volume weighted, are narrower if the earnings announcement is disclosed outside trading hours. The other measures of liquidity, quoted depth, total order book depth and weighted liquidity also indicate that order book depth, at all levels, is higher if the announcement is disclosed outside trading hours. The other variables employed by this research also provide clear evidence on differences between daytime and overnight earnings announcements. Both trading volume and average trade value are higher if the earnings announcement is disclosed outside trading hours. Moreover, the intraday volatility is significantly higher if the earnings announcement is

disclosed during trading hours, indicating increased uncertainty among investors. These findings provide further support to the findings of Pronk (2006), but contradict the earlier evidence provided by Libby, Mathieu and Robb (2002).

This paper provides mixed evidence of decreased liquidity and increased trading volumes around earnings announcements, a suggested reaction to increase in information asymmetry by Kim and Verrecchia (1994). During the pre-announcement period both spread and depth are insignificantly different from their non-announcement period median values, while significant improvement in order book depth variables is observed immediately after the disclosure of the earnings announcement. In accordance to Kim and Verrecchia (1994), theory the quoted spreads widen significantly during the first half-hour after the disclosure of the earnings announcement, but are narrower than their non-announcement period mean value thereafter. Evidence for the increase in trading volumes suggested by theory is provided as trading volume is statistically significant throughout the observation period. On this part my results fail to provide full support for the prior evidence of Libby, Mathieu and Robb (2002) and Lee, Mucklow and Ready (1993).

This paper also investigated Libby, Mathieu and Robb (2002) Hypothesis that the market reaction to quarterly and annual earnings announcements would differ. Although order book depth variables, quoted depth, total order book depth and liquidity are all significantly higher after annual earnings announcements, quoted spread and volume weighted spread show no difference between these two types of announcements. Therefore, the Hypothesis that there is no difference between relative spreads and relative depths before the disclosure of quarterly earnings announcement and before the disclosure of annual earnings announcement cannot be rejected. Nevertheless, documented significantly higher trading volumes suggest that for some reason investors prefer to trade around annual earnings announcements. Some of the reasons suggested by this paper are dividend announcements and proposals for the new board, both of which are commonly disclosed in the annual earnings announcement.

The fact that, this study has focused on market wide reaction to earnings announcement in limit order book market, unlike the prior research, has forced this study to focus also on market microstructure issues. The short review on these issues indicates, as suggested by Pronk (2006), that market models constructed by exchanges have effect on information dissemination process and therefore on the results presented by academics. The increased competition and consolidation in the exchange industry is likely to reduce discrepancies among market places and provide investors more optimal trading platform. However, for the time being researchers and market participants should avoid too broad generalizations.

In addition to the fact that harmonization in market models is needed, this paper has presented some variables that might be useful for the researchers. In particular, too little is known on volume weighted spread, which suggests that a significant proportion of the liquidity is also provided far away from the prevailing market prices. Why is so much liquidity provided on prices that are very unlikely to materialize into trades? And how does this affect the liquidity traders and price formation? These are some of the questions, which deserve answers as tools to analyse order book composition develop.

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